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Hollow Tile Construction

A Practical Explanation of Modern Methods of Designing and Building Fireproof Residences of Hollow Tile, written so the builder may use it, with chapters on walls, floors, roofs, partitions, framework, roofing, cornices, fireplaces and interior work, analysis of specifications, estimating, photographs and floor plans of finished structure, etc.

By

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Preface

Hollow tile has come into such general use, not only as a fireproofing material, but also for structural purposes, that it is entitled to treatment as a separate and highly specialized branch of the masons' art.

Up to the present time, however, no textbook or treatise has been published on the subject, giving in concise ready form rules, tables, and data to guide the busy mason when using hollow tile in practice. Further, what information there is on the subject is scattered through widely separated reports, documents and private papers, so that it is not in available form. For these reasons, and owing to the present active interest in the subject, it is hoped that "Hollow Tile Construction" will fill a want in the field of building literature, and be a guide in practical construction.

The aim of the author in preparing the manuscript was to present as simply as possible a work which would show: the several types of blocks; the various methods of construction; the numerous building details; rules and data to help the estimator in calculating costs; and numerous photographic reproductions of good examples of hollow tile construction.

To this end the illustrations were purposely made simple so as to shadow forth the principles of construction without clouding it with complicated details. Perspective drawings were used in preference to mechanical drawings where it was believed it would con-

vey to the mind a better mental picture of the general construction or any of its details; and an effort was made to insert an illustration where it was thought that a drawing would make clearer the text.

By an avoidance of technical terms and the presentation of the text in a simple manner, it was hoped to make "Hollow Tile Construction" valuable, not only in trade schools or wherever masonry construction is being taught, but likewise to the contracting mason and journeyman.

J. J. Cosgrove.

Table of Contents

CHAPTER I — PAGE

Types of Building Blocks 1

CHAPTER II

Special Blocks for Wall Openings 9

CHAPTER III

Wall Finish for Hollow Tile 17

CHAPTER IV

Hollow Tile Partitions 24

CHAPTER V

Tile Blocks for Bearing Walls 34

CHAPTER VI

Fireplaces, Chimneys and Oriel Windows . . 44

CHAPTER VII

Pipe Chases, Buttresses and Gables 53

CHAPTER VIII

Roofing Hollow Tile Buildings 62

CHAPTER IX

Floors, Roofs and Bulkheads 71

CHAPTER X

PAGE
Fireproofing with Hollow Tile 81

CHAPTER XI

Reinforced Flat Arches 95

CHAPTER XII

Construction of Combination Floors 109

CHAPTER XIII

Tile Used for Fire Protection 121

CHAPTER XIV

Protection of Beams and Girders 130

CHAPTER XV

Beam Filling and Floor Finish 138

CHAPTER XVI

Analysis of Specifications 145

CHAPTER XVII

Cost of Laying Hollow Tile 153

CHAPTER XVIII

What Equipment Should Be Charged For . . . 162

CHAPTER XIX

Good Examples of Hollow Tile Buildings . . . 168

Hollow Tile Construction

CHAPTER I

Types of Building Blocks

IN the study of law, whenever a student felt the growing importance of his knowledge and began to put on airs, the Professor had a way of bringing him back to earth with the simple question, "What is the rule in Shelley's Case?"

In like manner, if you want to start something among a lot of contractors and builders, just ask them what are the four modern essentials of a building.

Opinions will differ, of course, according to the perspective of the person; but if I were to lay them down in the order of their importance, I would say: strength; safety from fire; lightness of construction, and conservation of space by the use of thin walls.

As the last shall be first, so the first shall be last; and we will consider the four essentials in the reverse order of their enumeration.

The thickness of the walls of a building is the last essential enumerated, and apparently the least in importance; yet it has not only influenced but actually revolutionized the other three.

When cities were small and land was cheap, architects built massively, and walls of tall buildings were sometimes several feet thick. As cities grew in size, however, and city property sold by the square foot instead

of the acre, it became necessary to make every square foot of surface pay in rentals, and not only on one floor but on many.

But the taller the buildings, under the old order, the thicker the walls had to be to support them, and thus much of the building plot was taken up with masonry walls. This defeated to a great extent the object of building tall structures, so architects and engineers commenced looking around for a new type of construction which would combine all of the strength of solid masonry, or as much of it as was needed, with light floors, thin walls, and a skeleton that could be carried to great heights.

This brought into being the steel frame building, and, as strength, safety and lightness were necessary elements in this type of construction, brought about the evolution of hollow tile building blocks.

And it is the evolution of hollow tile blocks that will be treated in this series—hollow tile in all its phases from its structure to its cost. Heretofore hollow-tile construction has been handled to a large extent by specialists in that type of construction. Now, however, the demand for the material is becoming so general that contractors in remote regions must be able to estimate the cost profitably and handle the material economically.

The Two Uses for Hollow Tile

Hollow tile blocks are used in two entirely different capacities: these are structural and fireproofing. Of course as a structural material the blocks are fireproof, but that is incidental to their nature. When used for

fireproofing it is NOT used structurally but to protect less refractory materials.

These two functions of hollow tile blocks will be separately treated, but we will first take up consideration of the blocks for purely building or structural purposes.

There are two distinct types of building blocks used for the bearing walls and partitions of all kinds of buildings from residences to hotels, factories and business structures in general. The first of these types is shown in Fig. 1. The second in Fig. 2. Both of these types have given perfect satisfaction in practice, and both are well worthy of a better acquaintance. It is not the block alone, however, we must get on speaking terms with, but we must know it in relation to the building when laid up in a wall.

FIG. 1.—A Type of Hollow Tile Block

The first impression made on a builder when he has little or no experience of hollow tile construction is that the hollow blocks are lacking in strength. That on account of their lack of solidity they are frail and will crush like an egg shell. Let us see how that proves out in practice, and in test.

It might be well to point out in passing that hollow tile building blocks of the type, Fig. 1, are to be set on end; they are not intended to be set on side or edge, and will crush under one-half their load when laid that way. For bearing walls, then, always set this type of hollow block on end. A tile block set this way will sustain a

load of over 160,000 pounds, or 80 short tons, without failing. In other words it is safe to assume that hollow tile building blocks set on end will not crush under a load one ton per square inch of material actually bearing the load.

So much for the strength of the individual tile; but hollow tile blocks are not used individually. It is the strength of the structure when laid in a wall that the architect and builder are interested in.

It may be stated, then, that it is good practice to

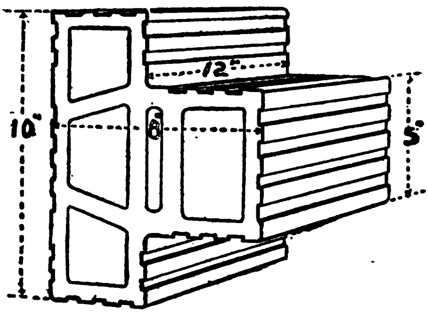


FIG. 2.—Dimensions of a Type of Hollow Tile Block

limit the height of hollow tile bearing walls to fifteen times the thickness of the blocks. According to that formula, the maximum height of bearing wall of 4-inch hollow tile would be $15 \times 4 = 60$ inches; of an 8-inch hollow tile wall, $15 \times 8 = 120$ inches, or 10 feet. Then, the total allowable weight a 4-inch bearing wall will carry should not exceed 200 pounds per square inch of material in its cross section, and this weight should include the weight of the wall itself. As there are approximately 39 square inches of area under compression

in a 4-inch wall, this gives a permissible load on a 4-inch hollow tile bearing wall 5 feet high of 7,800 pounds per lineal foot. A hollow tile bearing wall built of 8-inch blocks has a higher permissible load per square inch of cross section. An 8-inch wall of height not greater than fifteen times the thickness of the block will safely bear a load of 400 pounds per square inch of tile section.

Strength of Tile Walls

As the strength of a tile wall depends on the number of square inches in each block that have a bearing

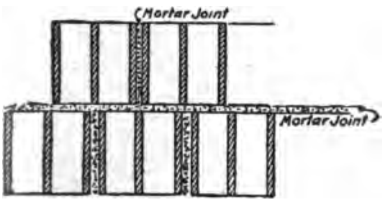


FIG. 3.—This Type of Hollow Tile Block Does Not Have a Firm Bearing

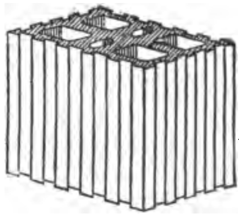


FIG. 4.—A Good Type of Block Affording Adequate Bearing Surface

surface, it is important to so bed each block in mortar that the shell and webs will all bear equally. It might be well to add in passing that the outside walls of a hollow tile block are known as the shell, and the cross partitions as the webs.

Equally important is it to have some surface for all the four sides of the shell and the webs to bear upon. By reference to Fig. 3, however, it will be seen that when laid in a wall, the end shells of the two adjacent blocks lack firm bearings. The cross partitions in the tile are approximately the same width as a vertical

mortar joint, so that the mortar alone has a firm bearing, while the end shells have bearings only where they cross webs.

To correct that seeming weakness in hollow tile construction, tile manufacturers make blocks, Fig. 4, with double cross webs at the center spaced about one inch apart. When these are laid in a wall, web and shell of all blocks have firm bearings throughout almost their entire cross section. The value of this additional cross

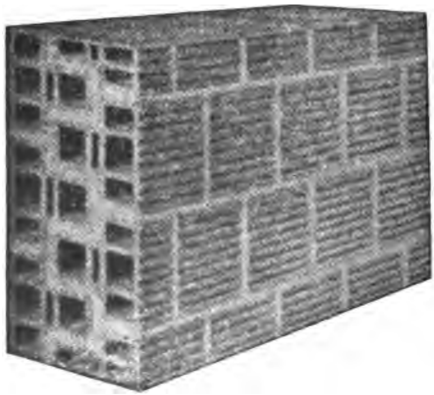


Fig. 5.—Interlocking Hollow Tile Laid in the Wall

partition or web will be realized when it is known that a wall built of these blocks is approximately 2½ times stronger than one built from ordinary blocks. However, the difference is more fancied than real so far as ordinary construction is concerned, for the single web blocks have so much strength to spare that a wall built of them if properly proportioned is never taxed to anything like its limit, but usually possesses a factor of safety of about eight.

It is well to know the different types of blocks that can be had, however, what they will stand, whether there is danger of them collapsing under the conditions used, and what blocks will give greater strength if a stronger bearing wall is needed.

The interlocking tile, previously mentioned, is laid on its side instead of end, yet possesses as much strength as the end-construction tile. This is due to the fact, as may be seen in Fig. 5, that when laid in a wall the shells and webs are all in line, one above another, so they are all bearing surfaces. The strength of the individual blocks is thus maintained, and is not reduced or weakened when laid in a wall. Numerous large buildings many stories in height have been built of these tile.

The peculiarity of hollow tile building blocks over bricks lies in the fact that special blocks are provided for water tables, belt courses, door openings, window jambs, sills, lintels, corners and caps. These special blocks, in turn, while they are the same in a general way for ordinary hollow tile and interlocking tile, yet differ in detail, so it will be necessary to consider them separately and in connection with the blocks with which they are to be used.

Grades of Hollow Tile

Before taking up the subject of details, however, it will be well here to point out the fact that hollow tile blocks are made in three qualities, known respectively as *dense*, *porous*, and *semi-porous*.

Dense hollow tile has a dense texture or body and possesses a low degree of absorption. It is not mate-

rially affected by exposure to the elements, and having a big degree of resistance to crushing is a good material where heavy loads must be carried. Porous hollow tile are made by mixing sawdust with the plastic clay. The sawdust is destroyed by the intense heat of the kiln, leaving the finished product full of little cells like those of a sponge.

Semi-porous hollow tile are made by mixing a certain percentage of finely pulverized coal with the plastic clay. This coal burns out during the process of firing, leaving the blocks of a porous texture just the same as when sawdust is used.

We will have more to do with porous and semi-porous tile in connection with the subject of fireproofing. Owing to the cells they contain, they will absorb a large amount of water so are not suitable for exposed places, particularly in cold climates, as the alternate wetting and freezing would soon destroy the material. These grades are at their best when used for the interior of buildings. Owing to a certain flexibility which they possess, they will not fail, even under severe abuse. Semi-porous and porous tile will not crack or break from unequal heating, or from being suddenly drenched with cold water when in a heated condition. Owing to their porous texture, nails and screws can be driven into them so that they are very suitable materials for interior partitions, as trim can be nailed or otherwise fastened direct to the tiling. Then, too, they are easily worked and can be cut with an ordinary carpenter's saw or other edge tool.

CHAPTER II

Special Blocks for Wall Openings

In masonry construction, window and door openings are provided with a sill. Up to recent years this sill was invariably of stone, although more recently cement concrete has superseded stone to a large extent.

In hollow tile construction, stone and concrete sills are dispensed with, special hollow tile blocks having

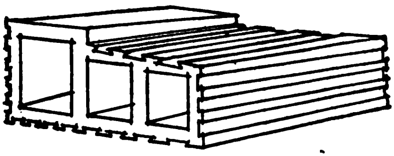


FIG. 6.—A Sill Block

been provided for this purpose. Illustration of a sill block is shown in Fig. 6. These are made in varying widths for use in walls of various thickness and may be used in connection with brick walls when desired.

The manner in which sill blocks are used, and the way in which a window frame and casing are built to them, is shown in Fig. 7. The illustration shows the outside of the sill blocks and outer walls of the building stuccoed, although both walls and sills may be left rough, as is commonly done in factory and other industrial buildings. Where the window frame rests on the sill, it is good practice to bed it in roofers' cement

to prevent wind and rain from blowing through. It is well, also, to fill in under the outer part of the window frame where it rests on the sill with cement mortar.

If it is desired to use cut stone sills instead of the hollow tile sill blocks, they can be used, and the tile work is then built up as shown in Fig. 8. Stone, cement or composition sills of any kind may be used in this manner. The illustration shows the stone window sill backed up with a hollow tile filler. This is purely for economy, however, as the stone sill could extend through to the inside surface of the wall. The additional depth of stone would add so much to the cost of the sill, though it is less costly and just as satisfactory to use a filler.

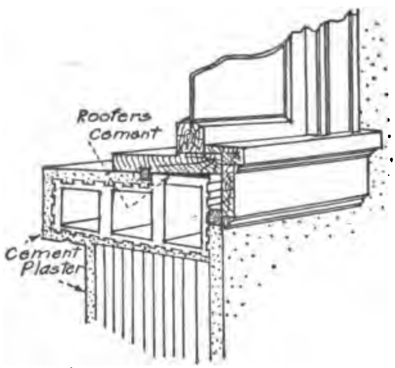


FIG. 7.—Window Construction in Hollow Tile

In laying up a brick wall, the outer course of brick is generally allowed to project a few inches into the window opening to form a sort of rabbit. In hollow tile construction, special jamb blocks are provided for this purpose. A full jamb block is shown in Fig. 9. They are made for walls of varying thickness, from 6 inches to 12 inches. If thicker walls than 12 inches are to be built, these same blocks can be used, breaking joints.

In order to break joints along the face of a wall without cutting tile, half jamb blocks, Fig. 10, are provided.

They play the same part that a half brick would as a course starter or closer. Like the full jamb blocks they are made for walls 6, 8, 10 and 12 inches in thickness.

Shrinkage of Timbers

A few words of caution for the careful builder who wishes his work to make his reputation might not be amiss. One is, be sure the window and door frames are so set and sealed that they are not only tight when put in, but will remain permanently tight against wind and rain. Remember all woodwork shrinks. This can be seen by the way baseboard and floor part company when a building dries out. In bathrooms it is the cause of 100 per cent of leaks where water closet and soil pipe come together unless flexible metal-to-metal floor connections are used. It is shown in the cracking of plaster, sticking of doors and numerous other ways.

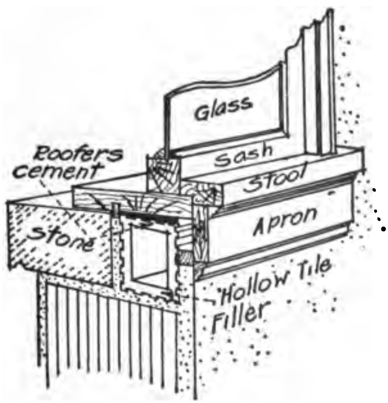


FIG. 8.—A Cut Stone Sill Used in Connection with Hollow Tile

The United States Department of Agriculture, Division of Forestry, made a very careful investigation of the shrinkage of timber for the benefit of building practice, and the result of their investigations is condensed in the following table:

TABLE I

SHRINKAGE OF TIMBERS

Size of Green or Wet Timber	Amount Lost by Shrinkage	Size or Depth of Timber When Dry
6 inches	.24	5.76 inches
8 inches	.32	7.68 inches
10 inches	.40	9.60 inches
12 inches	.48	11.52 inches
14 inches	.56	13.44 inches
16 inches	.64	15.36 inches
18 inches	.72	17.28 inches
20 inches	.80	19.20 inches

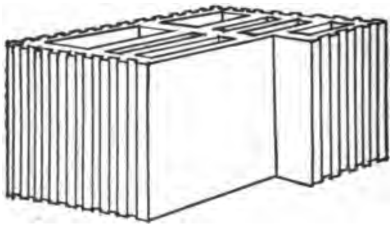


Fig. 9.—A Full Jamb Block

The shrinkage of timber and lumber affects all wooden door and window frames, therefore special care should be taken to thoroughly caulk between all woodwork and hollow tile.

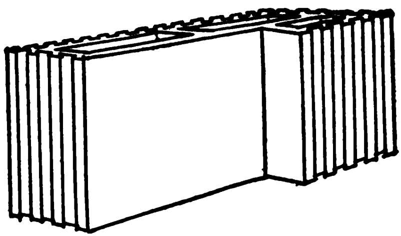
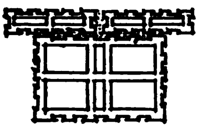


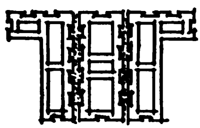
Fig. 10.—A Half Jamb Block Used to Break Joints Without Cutting Tile

Window Sill Drips

The drip from window sills is of no less importance, at least to the owner. Every builder has seen otherwise beautiful stuccoed houses disfigured by dark stains under the windows where water followed down from the sill, which was improperly designed or installed.

To understand thoroughly the principle according to which window sills should be made, it is necessary first to know something about the action of water when flowing along different surfaces. Try the following simple experiments: Take a pitcher of water and pour it against the outside of a tumbler. Instead of a tumbler, a piece of sheet metal may be used. It will





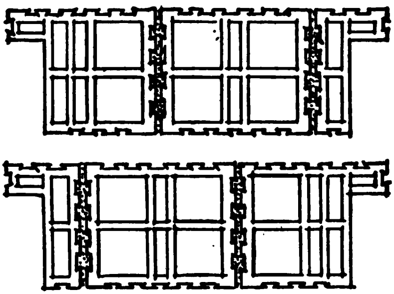
FIGS. 11 and 12.—Sections Through Wall Between Window Openings

be found that when the water reaches the lower edge of the tumbler or sheet metal, *provided it has a square edge,* the water will continue to flow downward in its course. If now the tumbler be turned on side, the water will follow the side of the tumbler adhering closely to the glass until it reaches a point where the glass curves upward, when the water will fall to earth. This action of water may be depended upon when in contact *with any surface it can wet.* It will behave differently if the surface be greased, which destroys the adhesion.

Applying this principle to building practice, it will be seen that if the under edge of a sill—water-table, belt

or other projecting course—is slightly rounded, slopes *toward* the building, or is even level, water will follow along the under surface of the wall, thereby wetting and staining the stucco. If, on the other hand, the under surface of the sill or belt course slopes *away* from the wall, the rainwater will spill clear of the wall and no discoloration will take place.

The following practical illustration of how hollow tile is laid around window openings ought to prove interesting to the mason and suggest to him how he can best



Figs. 13 and 14.—Alternating Courses in Pier Construction

lay out his work. Fig. 11 shows a short section of wall between two window openings. It will be observed that the windows are so spaced that one full jamb block and one-half jamb block just fill the space. By reversing the jamb and half jamb blocks as shown in Fig. 12, it will be seen that it breaks joints across this short section of wall, the courses, shown in Figs. 11 and 12, alternating with each other.

A simple way of building up a narrow pier or section of wall between two window openings, and at the same time breaking joints so as to maintain the strength of

the wall, is shown in Figs. 13 and 14, one large wall block and two thin partition blocks making up one

FIG. 15.—Plan of Hollow Tile Wall with Window Frame and Sash in Place

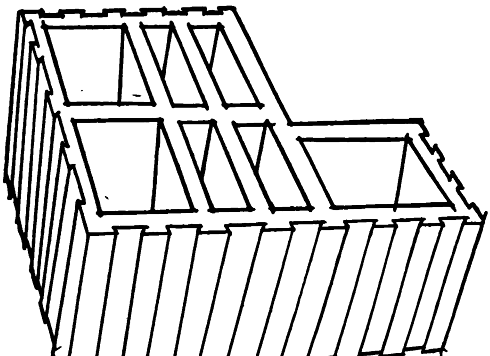


FIG. 16.—Tile Lintel for Window or Door Openings

course, Fig. 13, then two half jamb blocks with a thin partition block between makes up the other course, Fig. 14. This form of construction is for spaces too

narrow to permit the use of a jamb and half jamb block, reversing them to break joints.

In Fig. 15 is shown in plan a section of wall with a window frame and sash in place. This ought to convey a good idea of not only the mason work but likewise the carpenter work of setting the frame and putting on the trim.

Hollow tile caps or lintels for windows and doors deserve special mention. Special arch tile are provided for this purpose, which may be plain or rabitted, as shown in Fig. 16. Whichever type of block is used, however, they could not be used for spans greater than five feet. For wider openings concrete girders faced with tile, or stock tile reinforced with steel and concrete, should be used.

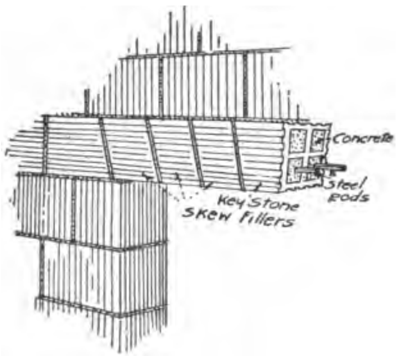


Fig. 17.—Reinforced Hollow Tile Arch

A reinforced arch is shown in Fig. 17. It consists of skewbacks at the sides of the opening to form abutments between which a flat arch is sprung, next come filler tile, and in the center of the opening the key block. The two lower cells of the tile blocks are filled with cement concrete in each of which is embedded a steel rod to take care of the tension in this part of the construction.

Extra wide openings generally have reinforced concrete girders sprung across them, and the girders are faced with tile.

CHAPTER III

Wall Finish for Hollow Tile

It would seem that but little of interest could be said about an ordinary wall of hollow tile; still, to the man who makes his living in the building trade, there is much to learn that will help him to keep his operations out of the loss column of the ledger.

One of the first considerations in designing or laying out a wall of hollow tile is to carefully space the window, door and other openings or breaks so that a certain number of tile with the necessary joints will just fill the space. This spacing of openings is not so necessary in any other type of construction; stone, concrete, brick or wood can easily be worked to fit any space. Hollow tile walls can be fitted out likewise, but it will affect a great saving in the cost of construction if all openings are so spaced as to avoid cutting.

Then, do not dump hollow tile from a wagon or truck, as bricks are dumped. Have them taken off and stacked each size by itself. This will save time in handling when ready to lay them in the walls, which will loom large in money saved at the end of the season. The saving in breakage, too, will more than pay for the cost of handling. The walls will present a better appearance when the tile are laid up than they would if corners and edges were chipped, and the improved appearance will add to the builder's reputation.

Chipped and broken tile are expensive to the builder

in another way. The more cavities to be filled in a wall, the more mortar and plaster it will require, and the more time for the laborer and mason carrying and applying the mortar. Care in handling all building materials pays, but more particularly in the case of hollow tile.

For the sake of appearance, and consequently reputation, do not patch out hollow tile with brick. Hollow

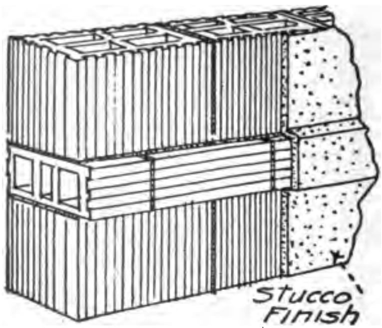


FIG. 18.—A Frequent Method of Laying Hollow Tile. This Method is Incorrect Because the Tile Laid on its Side Develops Only Part of its Strength, and the Wall is thus Weakened. The Correct Method is Shown in FIG. 19.

tile are made in the proper shapes and sizes, and it is only necessary to select the stock best suited to your needs when ordering.

Neither is it necessary to break up a lot of hollow tile when small pieces are required. A certain percentage of fraction tile are shipped with each order, and if properly stacked on the premises can be delivered by the helper or tender as wanted. This will affect a considerable saving both in time and material.

For architectural embellishment it is sometimes desirable to put a water table on the side of a wall built

from the footings up of hollow tile. This is sometimes done as shown in Fig. 18, which is an incorrect method, and a little study of the work will show why it is incorrect. As stated in a previous chapter, hollow tile when laid on side develops only from one-third to one-half the strength of the same blocks when set on ends. The strength of a hollow tile wall is, of course, no greater than that of the weakest course in the walls; so, if a bearing wall be laid with blocks on end, except one course which is laid on side, that one course will determine the bearing strength of the walls.

But when hollow tile are laid on side, the shells and webs are all in compression, as they come one above another. In the case of this incorrect method of water table construction, as can be seen by referring to the illustration, there is no web in the partition blocks used to form the water table, which will serve as a bearing for the outer shell of the tile. For this reason a wall with such a course would be weaker than a similar wall having one row of tile laid on side.

Notwithstanding that this is not considered good construction for ordinary building practice, this method may be used for one story buildings, particularly temporary buildings, where there is no load to bear other than the dead weight of walls, roof and snow or wind pressure on the roof. It is not recommended, however, and it is better not to adopt it in any practice.

Water Tables

The correct and approved method of running water table on hollow tile walls is shown in Fig. 19. This is simple, inexpensive and quickly run. All that is

necessary is to nail two furring strips the proper distance apart, wedging them from the wall to form a perfectly straight line, then fill in the space between the furring strips with neat cement, mortar, or concrete. If preferred, when a more ornamental course is to be run, it can be applied as all solid plaster mouldings in the interior are run by using one furring strip for a straight edge, and a zinc template for a runner.

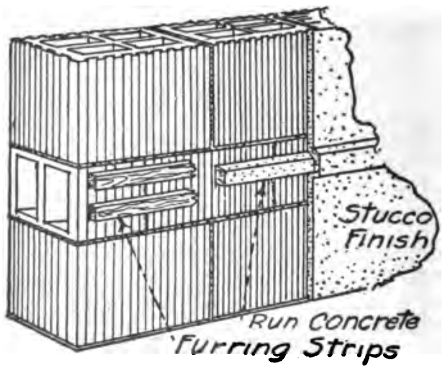


FIG. 19.—Building a Water Table on Hollow Tile. Two Furring Strips Are Fastened to the Wall, Acting As a Form. The Space Between Them Is Then Filled in with Mortar and the Strips Removed.

The mason cannot proceed far in the building of a hollow tile wall before provision must be made for the floor beams. This has been provided for in the manufacture of hollow tile, and he will find special blocks which greatly simplify this work, while at the same time preserving the bond.

In Fig. 20 can be seen a nest of one-inch tile. They are not to be used this way, but are made up in this form simply for convenience in manufacturing and

shipping. These nests are to be broken apart and the single slabs used for bearings under joists, sills, and for

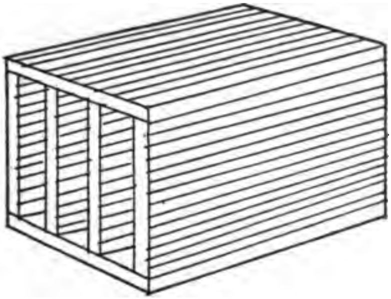


FIG. 20.—Hollow Tile Bed Plates for Floor Joists Are Shipped in this Form. They Are Later Broken Apart and Used as Shown in FIG. 21

working up to story heights. All that is necessary to separate the nests up into single slabs is to tap on the corners of the nests.

The manner in which a hollow tile wall is prepared

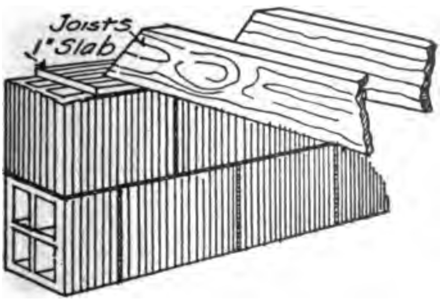


FIG. 21.—In Preparing a Hollow Tile Wall for Floor Joists, Bed Plates or 1-inch Slabs Are Laid Along the Top of the Wall to Form a Bearing Surface. These Tiles Are Also Used to Build Wall Up to the Proper Floor Heights

for a tier of beams is shown in Fig. 21. When the wall has been carried to the proper height, a layer of one-

inch slabs is laid along the wall to form a rest for the ends of the joists. Should the wall lack an inch of the required height, another course of slabs may be laid on top of the first one to elevate the joists that much. These slabs prevent at the same time the overturning tendency that would be present if the ends of the floor joists simply rested on the inside shell of the blocks. Stopping or closing the air cells at each floor, too, checks the tendency for air currents or drafts, thereby improving the insulating value of the wall against loss of heat.

It will have occurred to the builder by this time that at those levels where there are tiers of joists, the timbers

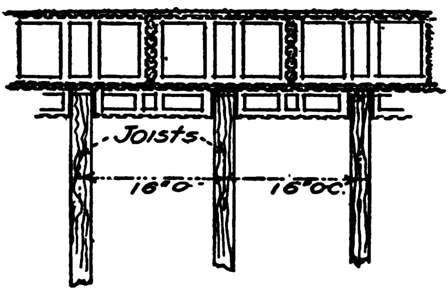


Fig. 22.—Plan of Joists Framed Into Hollow Tile Wall. Two Sets of Tile Are Used, as Shown

would interfere with the laying of the hollow tile blocks, and his ingenuity will be taxed to find a way out of the problem. The problem is not so hard to solve, however, as it would seem, but before explaining how to fill in this course, a word of caution will not be amiss.

Do not, then, cut holes in the tile blocks in which to frame the joists. Remember that the strength of the walls will depend on the bearing of web and shell, and every hole in a tile block weakens the construction.

The correct way in which to lay the course of tile at the joist levels is shown in Fig. 22. At the outside of the wall a layer of blocks of sufficient thickness to reach in to the ends of the joists is laid; then between the joists and breaking joints with the outer course are laid special beam filling tile. These blocks are of sufficient thickness to finish flush with the inside of the wall.

It is important that a good mortar be used for laying a bearing wall of hollow tile. It is recommended by the manufacturers that all mortar used for laying up hollow tile consist of a standard Portland cement and clean sharp sand in the proportion of one part cement and three parts sand, well mixed to a smooth, moderately stiff mortar. If the mortar is not moderately stiff, most of it will fall off the web and shells into the cells; while if the mortar is too stiff, the blocks will not settle to the proper bed.

As a rule it is not well to mix lime in any great amount with the mortar. A small amount not to exceed 10 per cent is not only permissible, however, but makes the mortar more workable. At night, or quitting time, care should be taken to cover the tops of all unfinished walls to protect them against stormy weather.

At the top of bearing walls, roof sills are provided to which the roof rafters are nailed. These roof plates must be secured to the walls to prevent the roof from blowing off. In hollow tile construction the roof plates are bolted to the wall. Three-quarter inch bolts twenty-four inches long are embedded in the two upper courses with cement grout at intervals of five feet. The bolts should extend six inches above the top of the wall, to allow the plates being fastened down with nuts.

CHAPTER IV

Hollow Tile Partitions

It is common belief among masons who have had no experience in hollow tile construction that while hollow tile partition blocks vary in thickness, otherwise they are all the same size. On account of this belief, I want to emphasize the fact that it is not true. Hollow partition tiles are commonly made in two sizes, namely, 12 inches high by 12 inches long, and 8 inches high by 12 inches long. Then, again, they can be had in any size required, but special sizes necessarily add to the cost of the material, and require more time for their delivery.

Partition tiles are made 2 inches thick, 3 inches thick, 4 inches thick, 5 inches thick and 6 inches thick. Stock sizes of the tile can be found in the accompanying table.

TABLE II

STOCK SIZES OF HOLLOW PARTITION TILE

2x 8x12	4x 8x12	5x12x12	8x12x12
3x 8x12	4x12x12	6x 8x12	10x12x12
3x12x12	5x 8x12	6x12x12	12x12x12

The comparative design in both porous and semi-porous material is shown in Fig. 23. It is not good practice, however, to use 2-inch blocks for partitions, except for closets or shafts, unless the courses are reinforced with metal.

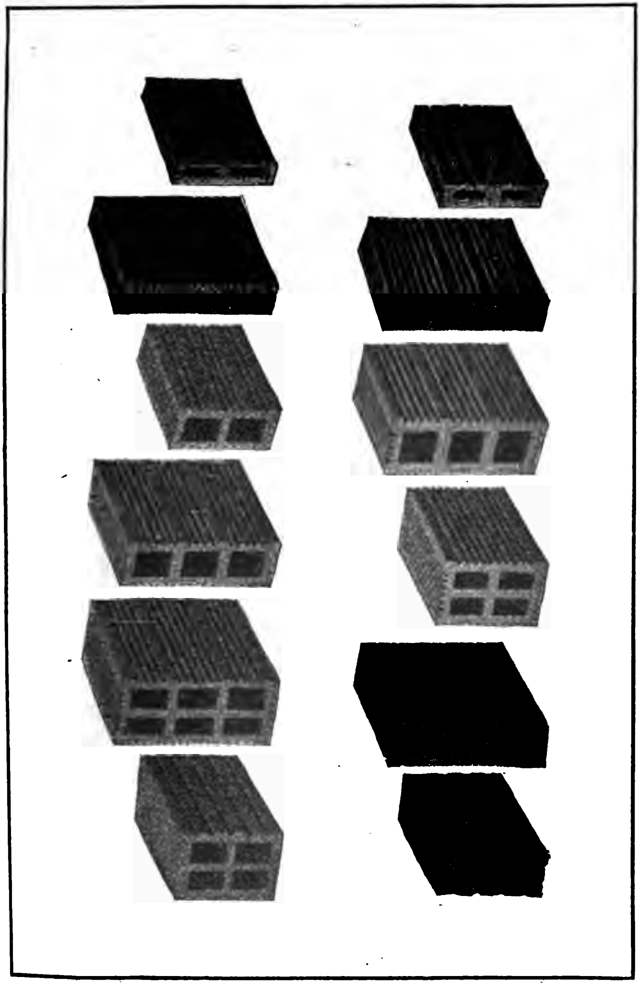


FIG. 23.—Partition Tile. The Left Row Illustrates Semi-Porous Partition Tile, the Right Row Porous Partition Tile

Height of Tile Partitions

Good practice limits the height of hollow tile partitions to 12 feet for 3-inch blocks, 16 feet for 4-inch blocks and 20 feet for 6-inch blocks. If 3 or 4-inch walls are to be carried higher than the limits set by good practice, are extremely long without side supports, or are exposed to wind pressure, they should be reinforced the same as 2-inch partitions.

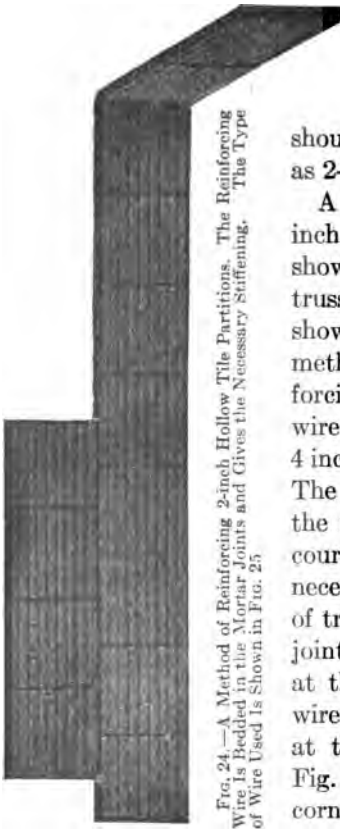


FIG. 24.—A Method of Reinforcing 2-inch Hollow Tile Partitions. The Reinforcing Wire Is Bedded in the Mortar Joints and Gives the Necessary Stiffening. The Type of Wire Used Is Shown in FIG. 25

A method of reinforcing 2-inch hollow tile partition is shown in Fig. 24, and the wire truss used for this purpose is shown in Fig. 25. This same method may be used for reinforcing wider partitions, and wire truss is made 1, 2, 3 and 4 inches wide for this purpose. The truss wire is bedded in the mortar in the horizontal courses, thereby giving the necessary stiffening. Instead of truss wire in the horizontal joints angle irons may be used at the corners. When truss wire is used, it is simply folded at the corners, as shown in Fig. 26, thereby stiffening the corners. For estimating the

cost of freight and carting, it is necessary to know the average weight of hollow tile. The weight per square foot of porous and semi-porous tile partition blocks can be found in the following table:

TABLE III

WEIGHTS, PER SQUARE FOOT, POROUS AND SEMI-POROUS PARTITION TILE

2-inch	16 pounds	6-inch	24 pounds
3-inch	16 pounds	8-inch	32 pounds
4-inch	18 pounds	10-inch	38 pounds
5-inch	21 pounds	12-inch	44 pounds

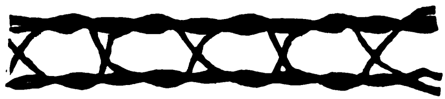


FIG. 25.—Wire Truss Used to Strengthen 2-inch Partitions. It Is Simply Bedded in the Mortar Joint

All partition and furring tile, unless otherwise specified, are scratched or grooved to form a key for the plaster. If the surface of the partitions are not to be plastered, but left bare or whitewashed, the tile are

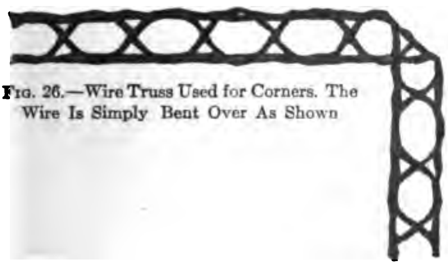


FIG. 26.—Wire Truss Used for Corners. The Wire Is Simply Bent Over As Shown

made smooth. It is necessary, however, to specify and order smooth tile when wanted.

Provision must always be made for bonding where walls come together and trim is to be fastened. It is

common practice in office buildings, hotels and like structures to have all the main corridor, stairway and elevator enclosures built of 4-inch blocks and partitions between rooms of 3-inch tile. Where two hollow tile partitions meet at an angle they should be bonded together. Where they butt against a brick wall they should be anchored by using tenpenny nails or special anchors at least every second joint.

Tile for interior partitions should be set on end the same as for outside walls, except the top course, which may be set on side. Indeed, it is better to set the top course on side, as it is then easier to wedge with slate between the top course and the ceiling.

Porous Tile in Partitions

About 15 per cent of the quantity of tile required for interior partitions should be of full porous material. Along the bottom course every second tile should be porous, and around door and other openings porous blocks should be provided. It will be recalled that one of the properties of porous tile is the ease with which nails can be driven into them. By using porous blocks, therefore, where trim will be secured to the wall, much time and consequent expense can be saved. If porous tile are not supplied to nail to, the walls will have to be plugged between blocks to secure nailing place for grounds or trim. While porous blocks are slightly more expensive than semi-porous or dense tile, they prove more economical than the denser material when used in the right proportion by the saving they effect in labor.

In school buildings where blackboards have to be

fastened to the walls, or in any other type of building where the walls must take and hold either nails or screws, all the tile should be full porous. This will make a slightly more expensive wall, but a much better one for the purpose.

Before starting to lay up a partition, wood or channel iron bucks or jambs should be placed in all doorway openings. These bucks or jambs should be 1½ inches wider than the thickness of the tile, so they will project three-quarters of an inch on each side of the partition and act as grounds for the plastering. The wooden

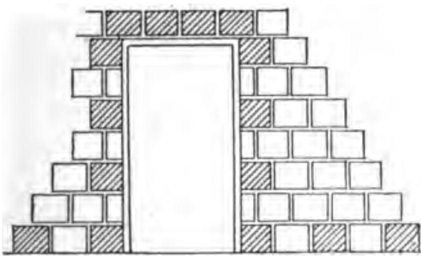


Fig. 27.—A Typical Layout for a Doorway in a Hollow Tile Partition. The Shaded Tile Indicate Porous Tile, Which Afford Nailing Surface

bucks or jambs should be anchored to the tile walls by means of tenpenny nails spaced at least in each second joint.

A typical layout for an interior partition is shown in Fig. 27. The wooden bucks are set in place in the doorway and stayed there with braces. Along the floor line where the baseboard must be secured to the wall every second block is of porous material. Along the side of the doorway in like manner every second block is porous. This is sufficient for nailing the trim

to, although some masons lay all the tile around the openings of porous material.

Closely allied to interior walls of hollow tile is terra-cotta wall furring, with which the mason should be familiar, as it will often aid him in increasing his work, and will improve the fireproof qualities of a building. Brick walls exposed to the weather must be furred to prevent dampness reaching the interior of the plastered surface and destroying both the plastering and the wall decorations. Formerly this was done by means of wood furring strips, wood lath and plaster. Now furring tile of dense, semi-dense and porous materials are available for the purpose.

FIG. 28.—Furring Tile, Used to Fur Out Brick Walls, Taking the Place of Wood Furring Strips. The Method of Using Them Is Shown in FIG. 29

Fig. 28 shows one of these tile split apart and ready for use. When they come from the kilns these two halves are joined together, but the connecting webs are deeply scored, deep enough so they will part when tapped on the edge by a mason, but shallow enough so the tile will not fall apart while in transit.

These tile, or half tile, are made 12 inches square and in two thicknesses, 1½ inches and 2 inches. Their weight per square foot is 10 pounds. The tile are set with the ribs against the wall, as shown in Fig. 29, thereby forming a series of air spaces which effectively check the passage of moisture. They should be set with the ribs vertical and be secured to the wall by driving tenpenny nails in the joints of the brickwork, the head of the nail being bent down upon the tile, using a nail over every third tile in every second course.

The tile should not be bedded in mortar at the back, since that would defeat their object by making a solid connection to carry the moisture through.

FIG. 29.—The Furring Tile Are Set With the Ribs Against the Wall, Thereby Forming a Series of Air Spaces Which Check the Passage of Moisture. They Are Set With Ribs Vertical and Secured to the Wall by Nails Driven Into the Mortar Joints of the Brick Wall. The Head of the Nail Is Bent Down Upon the Tile

Where the walls must be straightened out to line with the face of the piers the 2-inch tile cannot be used. If the ceiling height is not too great 3-inch partition tile may answer well for the purpose. If the space is greater than the thickness of a 3-inch tile, the tile may be set out from the wall, leaving a clear air space behind them. In this case the furring should be braced at intervals by the use of drive anchors, or by using an occasional block of sufficient thickness to rest against the wall.

FIG. 30.—Hollow Brick, Made in the Same Sizes As Common Brick, Can Be Used As Furring in Walls Over 10 Inches Thick Where the Walls Are Not Exposed to Driving Rainstorms

Where walls are not exposed to driving rainstorms as, for instance, in courts, on the south side of buildings, or where the walls are more than 16 inches thick, they may be furred with

hollow brick, Fig. 30, made of the same size as common brick. The building law of New York City allows them to be included as part of the thickness of the wall. They cost but very little more than common brick, make the cheapest form of furring, and are sufficiently effective for use in the walls of warehouses, factories and like buildings. Porous hollow brick are made which will receive and hold a nail, and are used where trim must be secured to the brickwork. A wall laid up with hollow brick for the inner course is shown in Fig. 31.

FIG. 31.—A Wall Laid Up With the Hollow Brick Shown in FIG. 30. Porous Hollow Brick Are Made Which Receive and Hold Nails, Affording a Good Base for Nailing Trim

Hollow brick weigh 3⅓ pounds each. The header measures 2⅛ x 3½ x 7¼ inches, while the stretchers are 2⅛ x 3½ x 8 inches. Hollow porous stretchers are 2¼ x 3¾ x 8, while solid porous stretchers are the same dimensions as the hollow stretchers.

A feature of furring to keep constantly in mind is this: Most furring reduces the size of the room in which it is used by at least 2 inches. This is a most important consideration where land is at a premium and rooms at their best are small. It is of less importance in institutions and country buildings where the buildings sprawl rather than grow tall. The hollow brick offers one means of economizing space for certain classes of city

buildings, but unfortunately are not sufficient for all walls under all conditions.

Closely akin to walls furred with furring tile or hollow brick is the combination wall of hollow tile and face brick, shown in Fig. 32. This seems to serve all the purposes for which it was intended; beauty, economy, moisture proof, heat retardant and ranks high in

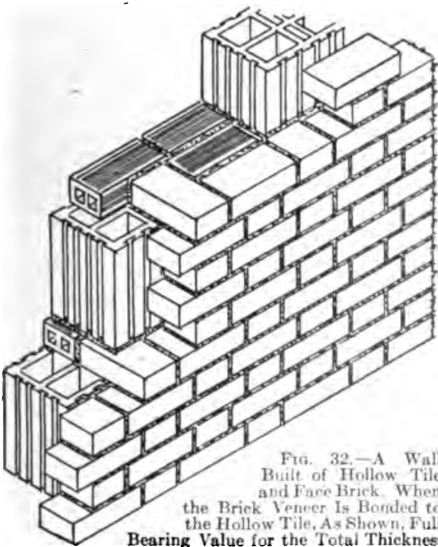


FIG. 32.—A Wall Built of Hollow Tile and Face Brick. When the Brick Veneer Is Bonded to the Hollow Tile, As Shown, Full Bearing Value for the Total Thickness of the Wall Is Allowed. When the Brick Veneer Is Secured By Metal Ties Only, the Hollow Tile Backing Alone Can Be Considered As Bearing Thickness.

the economy of space. It will be noticed the brick veneer is bonded to the hollow tile; where this is done full bearing value for the total thickness of the wall may be allowed. When the bricks are not bonded into the wall, but are secured with metal ties, only the hollow tile backing can be considered as bearing surface or a bearing wall.

CHAPTER V

Tile Blocks for Bearing Walls

So far we have considered chiefly the standard form of hollow tile blocks commonly used for bearing walls and partitions in buildings. It will be well, therefore, to turn aside for a while to study new and special types of load bearing tile and become familiar with their use in everyday practice.

In Fig. 33 is shown in perspective a load-bearing tile which does not seem to differ much from an ordinary tile, yet it differs so in use that it would show lack of knowledge of the building art to use them in the same manner.

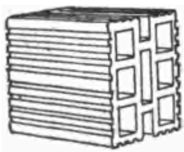


FIG. 33.—A Type of Hollow Tile Block Designed Especially for Laying Up on Edge. The Advantage of This Is That the Mortar Can Be More Easily Spread and There Is Afforded a Better Bearing Surface

The chief point of difference is in the way this type of block is laid. Whereas an ordinary block is laid on end, and it is poor construction, to say the least, to lay them on side or edge—this block is designed to be laid on edge, and it would be poor construction to lay them on end, except in special cases which will later be mentioned.

An advantage of laying tile on side lies in the greater ease with which the top course can be spread with mortar to form a bed for the next course, and the better bearing surface presented. This saves both in time and in mortar and insures a firm bearing along the

entire contacting surfaces. Another feature to be noted is the cross-shaped key or bond formed of cement mortar at each horizontal joint.

But all of those features would be of no avail if the shell and webs of the bearing blocks were not in compression when laid in a wall. A glance at Fig. 34 will now show that the shell and webs of this type of block are in perfect alignment when properly laid up. There is not an overlap anywhere and not a bit of the strength of the tile that is not lending its support to the wall.

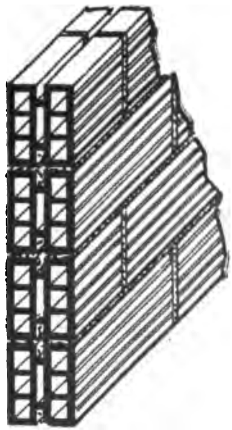


FIG. 34.—This Shows Laid Up in a Wall the Tile Illustrated in FIG. 33. Note the Cross-shaped Key or Bond Formed of Mortar at Each Joint. The Shells and Webs of These Blocks Are in Perfect Alignment

It is necessary to carry only two sizes of blocks to build walls of any thickness from 8 inches up to 80 inches with these bearing tile. These are 8-inch blocks and 4-inch blocks. Fig. 35 shows how the 4-inch blocks are used with 8-inch tile to form a 12-inch wall. By starting with a half tile 4 inches thick for one course, and 8 inches for the next, joints are broken; and by using 8-inch blocks, as shown in some of the other illustrations, the wall can be made any thickness and finished off with half tile on the opposite side wherever they are needed.

Of course special sill tile, jamb tile, corner tile and blocks for the various purposes already described for ordinary hollow tile are provided with this type. It will not be necessary to describe them here, however,

for they differ only in detail from those already illustrated and described, and they will be recognized in the details shown.

With the standard size of tile of this make, face brick, when used, can be bonded every ninth course. This is well shown in Fig. 36. In order to make the bond, however, a hollow brick must be used as a filler. This provides a hollow tile or an air cell along the entire inner surface of the wall, and the thicker the wall the greater the depth of cells between the inner and the outer surfaces.

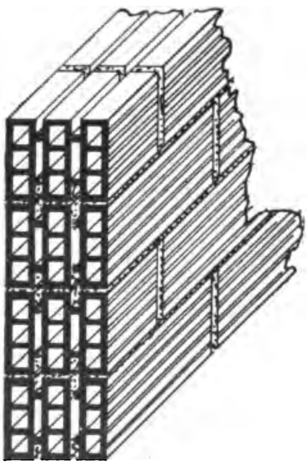


FIG. 35.—Only 4-inch and 8-Inch Blocks Are Necessary to Build Any Thickness of Wall from 8 Inches to 80 Inches. This Illustration Shows 4-inch and 8-inch Tile Laid Up in a 12-inch Wall. Joints Are Broken, the 4-inch Tile Course Being Laid Alternately on Each Side of the Wall

It might be well to mention in passing that load bearing tile of this type are made two cells in height as well as three, as shown in the illustration. When a wall with brick facings is being laid up in ninth-course headers and two-cell blocks are used, three tiers are necessary to make up the height that is made up with two tiers of three-cell tile. As it takes just about as long to lay a row of two-cell tile as it does three-cell tile, it will be seen that it is more economical to use the three-cell tile when possible. The saving in time lay-

ing a thick wall would be fully one-fourth over the time required to lay up a similar height and thickness with the two-cell tile. One-cell bearing tile are likewise made. For comparison the two-cell and one-cell are shown in Figs. 37 and 38. They are shown, too, laid up in thicker walls in order to illustrate the method of bonding used with load-bearing tile. By using different combinations of the three sizes of tile shown brick facings can be bonded every 5, 6, 7, 8 or 9 courses.

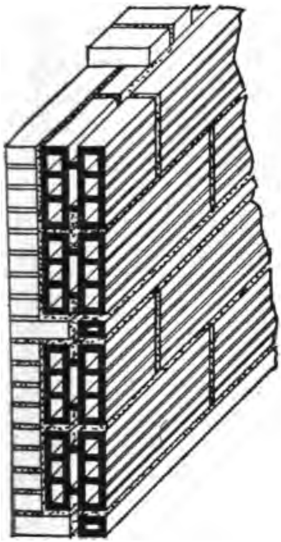


FIG. 36.—Face Brick Can Be Bonded in Every Ninth Course in Connection with Hollow Tile, As Shown

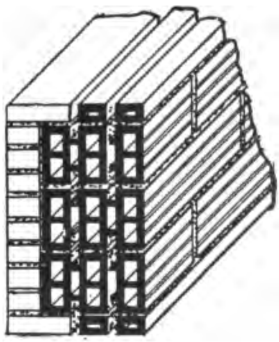


FIG. 37.—Two-Cell Tile and Hollow Brick Laid Up with Face Brick

It is a characteristic of hollow tile that when laid on side or edge the end of the wall, unless it abuts against or intersects another wall, will show open cells for the full height and width the blocks are laid. This, of course, would not be a satisfactory state of affairs around door and window openings, so in practice special

closure blocks are used and are set on end. This is shown in Fig. 39, which is a section through a window jamb, and Fig. 40, which is a section through a door jamb. These details show window and door frames used in combination with brick-faced walls of load-bearing tile. With tile walls stuccoed special jamb blocks would be used. Fig. 41 shows in section the detail of a window or door opening of wide span in a wall of load-bearing tile faced with brick. There are a couple of points about this detail of construction which it will be well to make particular

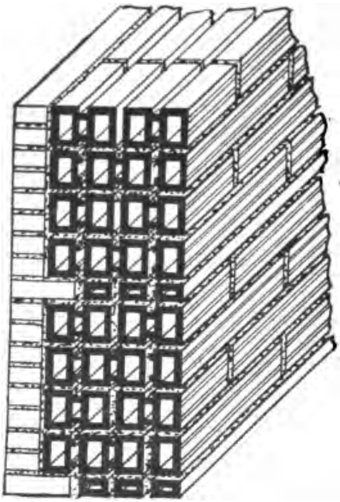


FIG. 38.—Tile One Cell High Can Be Used. It Is Cheaper to Lay a Wall with the Three Cell Tile, As the Higher Tile Need Less Labor in Setting for a Given Height of Wall, Besides Requiring Less Mortar

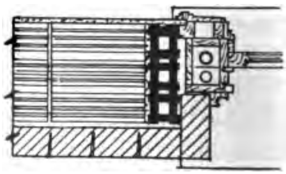


FIG. 39.—When Hollow Tile Are Laid on Side or Edge, Open Cells Are Left the Full Wall Height Unless Special Closure Blocks Are Used or Unless the Tile Butt Against Another Wall

mention of. In the first place, the tile span is carried on a T iron or two angle irons set back to back. When this form of reinforcement is used the up-turned edges of the iron support fit in the groove of the tile, so that the bearing shells and webs come one above another, thus being under compression. Instead of

using T irons or angle irons, the blocks forming the window head may be reinforced with steel rods bedded in concrete as for other forms of hollow tile; keyed arch tile, either flat or curved, may likewise be used.

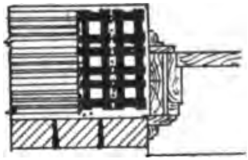


FIG. 40.—Section Through Door Jamb Showing Use of Closure Tile in Connection with Brick-faced Hollow Tile Wall

It might be well to answer here some questions which have been raised on the subject. The question has been asked whether when flat arch tile are used it is necessary to reinforce them, and what is the simplest and easiest way in practice to reinforce window caps or lintels.

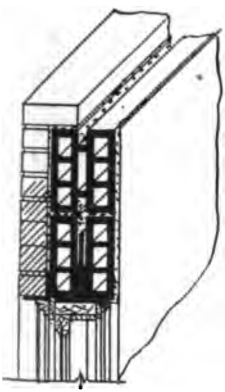


FIG. 41.—Section of Window Opening of Wide Span, Showing Head Construction. The Tile Span Is Carried on Either a T Iron or on Two Angle Irons Set Back to Back

To clear up the doubt about flat arch tile, it is only necessary to say that no form of arch needs reinforcement if properly proportioned and built. Flat window caps are no exception to this rule, so when keyed caps are used it is not necessary to reinforce them. Like all arches, however, they should have abutments of suitable strength and weight against which to rest.

The simplest way to reinforce window and door caps in practice is to build them and allow them to set before using. Cut the steel reinforcing rods the right length, then set upright on the floor one of the end blocks of the cap. Place in this the reinforcing rods, seeing to it that they are

properly spaced and aligned, then fill the cells of the tile with concrete. Place a second block on top, fill it with concrete, and continue until the right length of cap is made. Some masons find it easier to set up the tile on planks set at an angle of from 20 to 45 degrees.

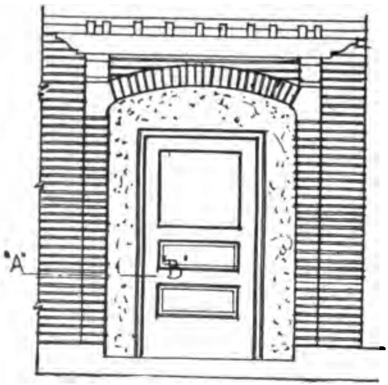


FIG. 42.—Detail of Entrance Doorway in Hollow Tile Cottage Faced With Brick. A Detail Through the Wall at "A-B" Is Shown in FIG. 43

Returning to our detail of window heads, it will be noticed that the brick arch is not sprung across the opening to carry the face brick. On the contrary the horizontal courses of brick are continued across the opening. This makes a very pleasing window or door finish, but necessitates some way of supporting the brickwork. In this case, as shown by the detail, an angle iron is used for the purpose, and the window stop of the frame is allowed to extend up between the reinforcement supporting the tile blocks and the angle iron supporting the brick as a stop-draft.

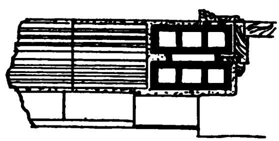


FIG. 43.—Section Through A-B of FIG. 42

In Fig. 42 is shown the detail of an entrance doorway in a hollow-tile cottage faced with brick, in which a pleasing combination of stucco finish and brick veneer

is used. The brickwork around the opening terminates with a brick pilaster and arch, and from the inner edges of the pilasters to the door jamb the wall is stuccoed. Fig. 43, a detail through the wall at A-B, shows how the stucco is returned around the corner. Another use for the groove in load-bearing tile will be seen in the way a stop is built into the groove. This not only anchors the door jamb in place, but effectually prevents leakage of air or cold around the door frame.

Detail showing the canopy over the doorway may be seen in Fig. 44. Here we have two angle irons supporting the tile over the doorway, but the brickwork being arched there is no need for iron or steel support, so none is shown.

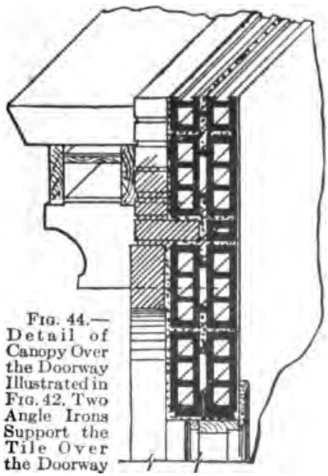


FIG. 44.—Detail of Canopy Over the Doorway Illustrated in FIG. 42. Two Angle Irons Support the Tile Over the Doorway

Load-bearing tile are burned hard, standard and medium. Standard-burned tile should be used in walls to be veneered with brick, cemented or stuccoed. Standard-burned tile has just about the right degree of absorption to retain the proper amount of moisture to form a perfect bond and keep mortar, cement or stucco from creeping. In working upon the surface of standard-burned tile wetting down is unnecessary.

Hard-burned tile has very low moisture absorption and should be used for exposed surfaces where no

veneering is to be applied; such as silos, stacks, unfinished outer walls of buildings, or any unprotected exterior wall.

TABLE IV

CARRYING CAPACITY IN POUNDS OF LOAD-BEARING TILE WALLS

Carrying capacity, in pounds, of different heights of various thickness Load-bearing Tile walls, per lineal foot, including weight of tile and mortar; based on tile complying with specifications following and using safety factor of 10 to 60 pounds per square inch.

Data based on authentic engineering tests.

Actual Thickness Wall	Height of Wall								Weight per Sq. Ft.
	15′—0″	14′—0″	13′—0″	12′—0″	11′—0″	10′—0″	9′—0″	8′—0″	
8¼″	5,340	5,380	5,420	5,460	5,500	5,540	5,580	5,620	40 lbs.
13″	8,460	8,520	8,580	8,640	8,700	8,760	8,820	8,880	60 lbs.
17¾″	11,580	11,660	11,740	11,820	11,900	11,980	12,060	12,140	80 lbs.
22½″	14,700	14,800	14,900	15,000	15,100	15,200	15,300	15,400	100 lbs.
27¼″	17,820	17,940	18,060	18,180	18,200	18,320	18,440	18,560	120 lbs.

Medium-burned tile should be used where a semi-porous tile is commonly used for interior work only.

The following tables and rules will be found useful in practice for determining the safe weights for walls of different heights and thickness built of load-bearing tile. Copy them and paste in a convenient place for ready reference.

TABLE V

HEIGHTS AND THICKNESSES OF WALLS

Maximum Heights for Walls		Minimum Thickness for Walls	
Stories	Wall Height	All-Tile	Brick-faced
1st story	18′—0″	27¼″	26¾″
2nd story	15′—0″	22½″	22″
3rd story	13′—6″	17¾″	17¼″
4th story	12′—0″	17¾″	17¼″
5th story	12′—0″	13″	12½″
2-story dwellings	22′—0″	8¼″	12½″

Rule 1—Wall thickness in dwelling, office and apartment buildings may be 4 inches less.

Rule 2—Where floor spans exceed 25 feet 0 inch wall thickness shall be increased.

Rule 3—Where length exceeds 125 feet 0 inch increase thickness 4¾ inches for each 25 feet 0 inch additional.

Rule 4—Openings exceeding 33⅓ per cent of wall area require increased wall thickness.

Rule 5—Interior bearing walls bonding into other walls may be diminished 4¾ inches—minimum 8¼ inches.

Rule 6—The use of metal ties, or bonding with headers further apart than every fifth course of brick veneering, shall not be considered in determining bearing area.

CHAPTER VI

Fireplaces, Chimneys, and Oriel Windows of Hollow Tile

Seeing is said to be believing, and if first sight is not always convincing, seeing things being done or how they have been done, is at least a very good way of learning what to do. For this reason several of the following pages will be devoted to showing pictorially how to construct special features of buildings out of hollow tile.

In the home no feature adds so much to the cheer, perhaps, as a fireplace. The building might be heated with steam, hot air or hot water, but unless there is an open fireplace in the living room there is no shrine around which the family can gather and be satisfied. Gazing at the flame of a wood fire or the glow of a coal fire is pleasant occupation, and one can never be lonesome, even when alone, in a room or building which boasts the companionship of an open grate fire.

In residence buildings of hollow tile we must, then, still have our fireplaces, and in Fig. 45 is shown how one may be constructed. All fireplaces, whether built of hollow tile, brick or other masonry material, should be lined with fire brick. This will preserve the fireplace during the life of the building from being burned out, as common brick, particularly soft-burned brick, are liable to burn out under frequent and high-temperature use.

Flue Linings

Terra-cotta flue linings must be provided in the wall to serve as a smoke flue, and the terra-cotta linings must be made tight at the joints or the draft of the

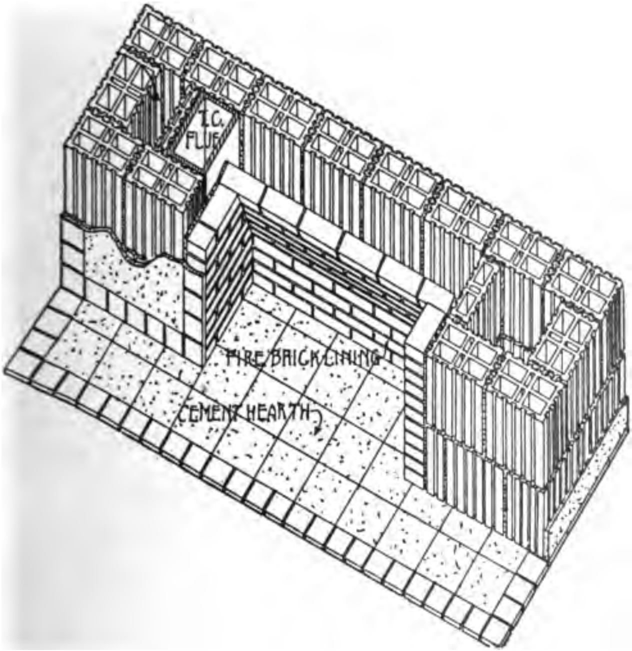


FIG. 45.—A Fireplace Built of Hollow Tile. Firebrick Is Used for Lining. Flues Have Terra Cotta Flue Lining

fireplace is liable to be spoiled by leakage of air where the joints are not tight. Then again, when a fire is first started in the autumn and the chimney is cold and damp the draft will be sluggish or negative, and smoke

and gas will leak through the unmortared joints and through the walls of the building wherever there are crevices through which it can force its way.

The terra-cotta flue linings ought to be backed up with hollow tile or brick, and it is well to put a damper in each fireplace so the draft can be shut off from the smoke flue when desired. Many rooms have been hard to heat, and the building consequently hard to rent, because large fireplaces opening into them had no means

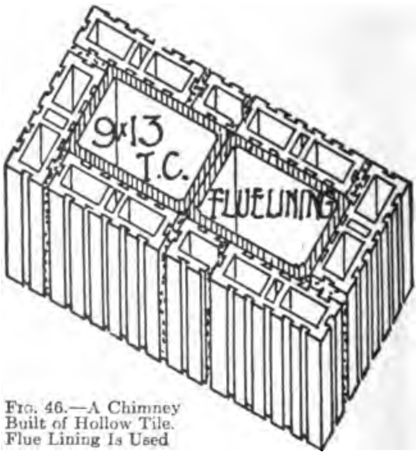


FIG. 46.—A Chimney Built of Hollow Tile. Flue Lining Is Used

of checking the draft in extremely cold weather; under such conditions, if the fireplace is not in use, the heat of the room will escape up the chimney and it will be impossible to keep the room warm.

Chimneys are important details in every building, and a hollow-tile chimney is shown in Fig. 46. This is a two-flue chimney, lined with terra-cotta flue linings,

and backed up with ordinary hollow-tile building blocks.

A chimney is a more important feature of a building than is generally realized, and as a consequence too little thought is sometimes given the subject when planning a building. From an architectural standpoint, it can make or mar the beauty of a building, depending on whether it is well placed or poorly placed; well proportioned or poorly proportioned, or extends too little or too far above the roof. It is one of the most conspicuous features of an ordinary home and some architects have been known to accentuate them, building the fireplace and chimney, as it were, and subordinating everything else to them.

From an engineering or practical standpoint, the subject of chimneys is of no less importance. On the right proportion and design of the flue depends the draft, and consequently the heating efficiency of the boiler or furnace, and this in turn affects the comfort, the habitability of the building.

It is important that a chimney be straight and smooth inside and proportioned to the area of the grate or the stove, range, boiler or heater. Only one smoke pipe should be permitted to connect to any flue, and no other openings should lead to it or it is liable to spoil the chimney draft.

Chimneys, whether of hollow tile or any other form of construction, should be cased with flue linings to give them a smooth interior surface. The best form for flue linings is round or oval, as smoke and hot gases pass up with less frictional resistance in a round flue than a square one. Square flues, on the other hand, are much

more efficient than rectangular ones, on account of the less surface exposed for a given area of flue. For instance, a flue 12 x 12 inches has an area of 144 square inches and a perimeter of only 48 inches, while a flue 8 x 18 inches, having an equal area, has a perimeter of 52 inches, thus presenting four additional inches to offer resistance. No satisfactory formula has ever been devised to calculate the area of smoke flues under vary-

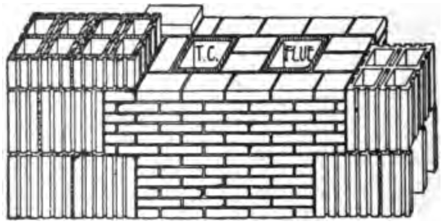


FIG. 47.—In Chimney Construction Brick Can Often Be Advantageously Used in Connection with Hollow Tile. This Illustration Shows a Good Practical Combination of Brick and Hollow Tile

ing conditions. A simple empirical rule that will be found satisfactory for ordinary purposes is to allow in the smoke flue an area equal to one-eighth the sectional area of the grate. Chimneys for fireplaces to burn wood or bituminous coal should have an area, respectively, of one-eighth and one-twelfth. If the fireplace is for burning anthracite coal, one-twelfth.

Brick can often be used to good advantage in connection with hollow tile in the building of chimneys, both for architectural effect and for practical results. A good practical combination of brick and hollow tile is shown in Fig. 47. This shows the method of bonding the brickwork of a chimney into a wall of hollow tile,

but the same method may be employed for bonding a pier of brick or the casing of a doorway with the body of the wall.

This illustration shows something else well worth bearing in mind. That is the solid way in which the flue linings are bedded in a solid wall of brick. If the bricks have been properly laid, the flue linings are solid and without cracks or breaks of any kind, and the joints all well set in a good Portland-cement mortar; this form of construction will last for ages, never leak, and always give the very best of service. Another feature of this construction which can be commended to the builder who is anxious to do good—and better—work, is the way the flue linings are kept separated. Too often in building a chimney the mason will bunch the flue linings in a group, four, six or eight together with nothing between. That is very bad practice for more reasons than one. In the first place, when the flue linings are bunched in that manner the joints are never tight and cannot be expected to be tight. The result is a great loss of draft in all the flues. In the second place, when a number of flues are bunched together without partitions between them, the wall is weakened greatly at that point for there is no cross bracing such as there would be if four-inch walls divided each flue lining from the others. This matter has been the subject of consideration by framers of building laws who insist that linings have around them at least 4 inches of brickwork and that a 4-inch partition be built in the walls between all flue linings.

Another interesting detail of buildings is an oriel window or a bay window. In Fig. 48 is shown in plan

an oriel window commonly called a bay window. As there seems to be some confusion in practice as to just what constitutes a bay window and what an oriel window, it might not be amiss to point out the difference here.

A bay window, then, is one which projects outward from the wall of a building and commences at the ground. An oriel window, on the other hand, is one which projects outward from the wall of a building but which starts from and is supported by brackets or

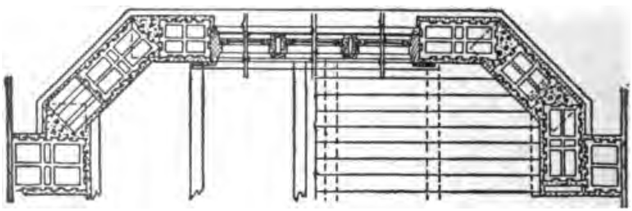


FIG. 48.—Method of Constructing An Oriel Window. The Spaces Between the Tile Are Filled with Concrete, Which Forms a Good Bond

corbels from the wall above the ground. A bay window might extend the full height of the building, or be only one story in height. An oriel window might extend the full height of a building above the first floor, or it may be only one story in height. But if only one story in height a bay window would have to be on the ground floor, and resting on the ground. An oriel window might be at any floor of the building and would be supported from the wall by means of floor extension, corbels or brackets. From the floor plan it will be seen that the hollow tile, when used in forming an oriel window, do not fit together as a plain wall, so the spaces

between must be filled with concrete. The corners are well bonded together, however, and the construction is a sufficiently strong one.

A section through the lower wall and floor of the oriel window is shown in Fig. 49. It will be noticed that the weight of the window is carried on a reinforced concrete

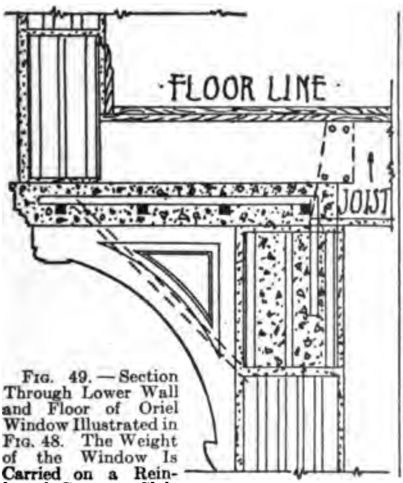


FIG. 49.—Section Through Lower Wall and Floor of Oriel Window Illustrated in FIG. 48. The Weight of the Window Is Carried on a Reinforced Concrete Slab Cast in Place, Which Is Supported By Reinforced Concrete Brackets Also Cast in Place.

slab, poured in place, which in turn is supported by reinforced brackets cast in place and bearing on the wall.

In Fig. 50 is shown a side elevation of the oriel window from which can be seen the ornamental face of a bracket, and the floor slab, both of which are formed by pouring or casting. In the laying of tile in the walls

of a bay window, brick can sometimes be used to very good advantage instead of concrete for filling the chinks. When they are used, however, they ought to be laid in a good bed of Portland cement mortar, and have all

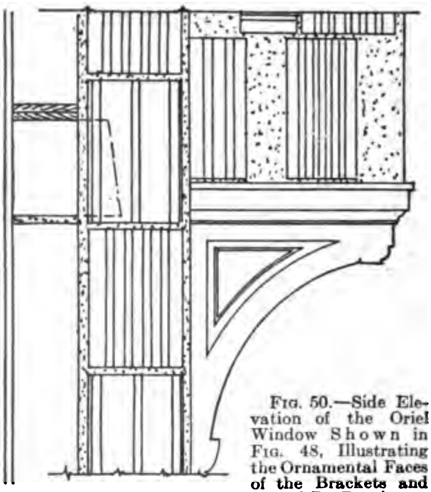


FIG. 50.—Side Elevation of the Oriel Window Shown in FIG. 48, Illustrating the Ornamental Faces of the Brackets and the Floor Slab, Which Are Formed By Pouring.

crevices flushed in with grout, not only to keep the building warm, but to insure good, strong construction which will so interlock with the tile as to lend strength to the wall and be in no danger of falling out.

CHAPTER VII

Pipe Chases, Buttresses and Gables

One of the precautions in building practice which will pay the most in time, in money and in good work, is to make provision for the steam pipes, plumbing pipes and hot air flues where they pass through floors and ceilings, and are run in walls and partitions. It is a precaution so seldom taken that the importance of it cannot be over emphasized in the interest of economy and good building. Provision for pipes is of importance in any kind of a building, but becomes of more importance in brick, hollow tile and reinforced concrete buildings. I have seen workmen spending days and weeks cutting through walls, partitions and floors of buildings to provide passage for pipes where provision should have been made in advance. The net result of their efforts was a big bill for labor, jagged holes where sleeves should have been built in, and gaping holes around pipes through floors where water when scrubbing can run down, while if sleeves had been properly built in there would have been raised bosses around the sleeves to prevent water from flowing through.

The providing of pipe chases, ducts and sleeves, in buildings ought to commence in the office of the architect. On every set of plans there ought to be marked the exact size and location of openings. As architects seldom have draftsmen well enough posted in the design of mechanical installations, however, to

take care of this part of the layout, the duty devolves naturally upon the general contractor. It will not do for the general contractor to brush this responsibility aside with the feeling that as it affects the work of a sub-contractor it is up to him to look out for the necessary provisions for his own work. Often the building

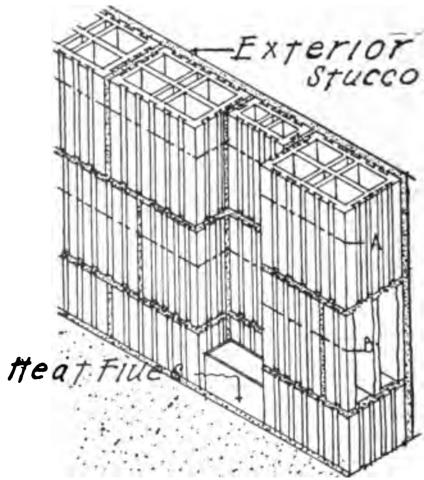


FIG. 51.—Building a Pipe Duct for Hot Air Flue. Pipe Chases Must Be Run Straight and in Good Alignment, with No Projections to Restrict Size

is too far advanced by the time sub-contracts are let for the sub-contractor to have the necessary work done. Besides afterthought is costly, and when all is said and done it is usually the general contractor who must do the cutting and patching, so it is his profits which will suffer if he neglects to act in time.

A good plan is to notify each sub-contractor as soon

as sub-contracts are let, to mark on the plans, and take up with the superintendent of the job, the holes they will want left, the pipe ducts to be provided, and all preparatory work for their respective parts of the contract. The manner of building a pipe duct for hot air flues from a furnace or indirect radiator stack, is shown in Fig. 51. It must be impressed on the minds of the masons, however, to run the pipe chases perfectly straight, in good alignment and with no projections to

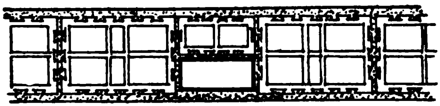


FIG. 52.—After the Pipes Are in Place, They Must Be Plastered in Like the Rest of the Wall. This Can Be Done By Stretching Expanded Metal Across the Face of the Chase, Which Takes the Plaster.

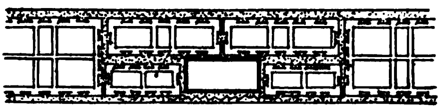


FIG. 53.—This Illustration Shows How to Break Joints Around a Pipe Chase

restrict the size. It is well to impress on them also the necessity of continuing the chase the full width from bottom to top, unless reduction of the ducts at different floors permits a corresponding reduction in the size of the ducts; and to make the chases at least one inch wider than the width of the hot air flues or pipes that will be concealed therein.

When the pipes are in place, and if necessary tested, they must be plastered in the same as the rest of the wall. The manner of doing this can be seen in Fig. 52. Expanded metal lath is stretched across the face of the

chase and secured in place, the opening can then be plastered when the rest of the wall is.

In Fig. 53 can be seen the manner of breaking joints around a pipe chase. This is very necessary from a practical standpoint, otherwise there will be a weak part of the wall on this line which is liable to crack, or

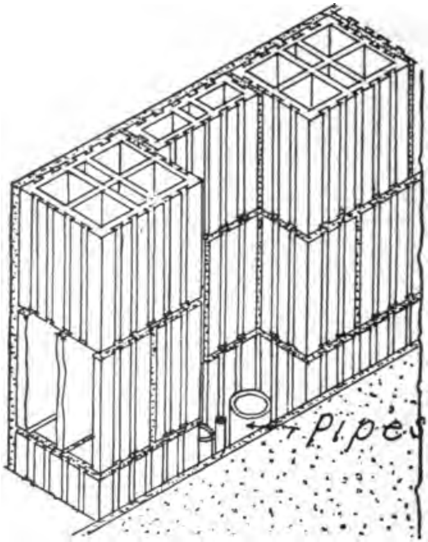


FIG. 54.—Pipe Chase for Plumbing and Steam Pipes

even to give way. By comparing Fig. 53 with Fig. 52 the manner of laying alternate courses will be seen.

Hot-air pipes are of uniform size throughout so it is a simple matter to determine the size of pipe chases for them. When we come to steam and plumbing pipes, on the other hand, a different condition obtains. Steam and plumbing pipes have hubs or fittings which are

much larger than the pipes, and the ducts must be made large enough to cover these hubs and fittings.

Ordinarily an allowance of two inches more than the size of the pipe marked on the plan will be sufficient. For instance, if the plan showed a 4-inch pipe run in a wall, and a pipe chase was to be built for it, allowing 2 inches over and above the size of the pipe would make the pipe chase $4 + 2 = 6$ inches square.

In considering the size of pipes it is well to keep in mind that the outside of a pipe is larger than the rated

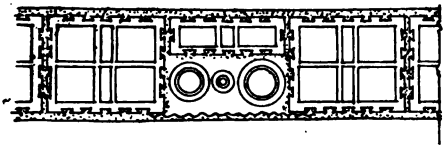


FIG. 55.—Plan View of Pipe Chase for Plumbing and Steam Pipes

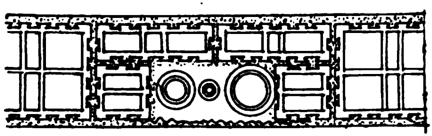


FIG. 56.—Plan View of Another Course. Compare with Fig. 55, Which Will Show How Courses Are Broken

size by an amount equal to the thickness of the walls of the pipe. For instance, a 4-inch pipe means inside diameter. If the walls of the pipe are ¼-inch thick, the outside diameter would be 4½ inches. As a matter of fact, 4-inch wrought iron and steel pipes are just 4½ inches outside diameter.

A pipe chase for plumbing and steam pipes is shown in Fig. 54. This is a small chase for only three pipes although frequently they are much wider. A plan view of the duct can be seen in Fig. 55, and by comparing

56 will be seen the manner of breaking the duct.

viously stated, pipe chases for plumbing ɔes are usually quite wide, and like pipe air pipes, they must be covered in front d metal or wire lath, so the pipes can be In the case of hot air pipe chases, the ɪll and the expanded metal lath usually the hot-air pipes, so that when plastered ive" at that point. In the case of steam pipes, on the other hand, the expanded t come in contact with the pipes only at fittings. As the spans are larger, this e to create a weak spot where the plaster f the plaster were not stiffened in some ɪn be done, as shown in the illustration, the wire lath to a studding provided for The studding may be of wood, 2 x 2 or ing to conditions, or in strictly fireproof gle irons or T irons may be used for this

Buttresses

ɪterior we will go to the exterior for the consider. The buttress is a very useful ɪe building world. It is found in dams, ls, factory walls, industrial walls of all in walls, and churches. In their simplicity s which bolster up the structure, thereby bear its load or withstand thrusts. In resses are raised to the highest degree of ɪrticularly in Gothic design where flying used.

In Fig. 57 is shown a buttress built of hollow tile. It is finished with stucco and has concrete cap and fill. This buttress is plain and simple in design, pleasing in appearance and easy to build. Fig. 58 shows a simpler design of buttress built of hollow tile with hollow tile coping and concrete fill. This is not nearly so orna-

FIG. 57.—Buttress Built of Hollow Tile, Stucco-Coated. It Has Concrete Cap and Fill

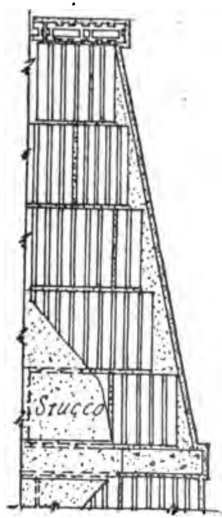


FIG. 58.—Another Type of Buttress, with Hollow Tile Capping and Concrete Fill

mental a construction, the sloping edge lacking the graceful lines of Fig. 57 produced by breaking up the sloping surface by means of a concrete weathering, from the top of which the wall continues in a vertical direction to the coping.

Buttresses are probably derived from the classic pilasters which serve to strengthen walls where there is

a pressure of girder or roof beam. Early English buttresses project considerably, sometimes with deep sloping weatherings in several stages, and sometimes with gabled heads. In some places on churches, they are richly ornamented with canopies and statues.

Gables

Gables are architectural features of great possibility when properly treated, and thought or lack of thought may make or mar their beauty. The old Colonial architects seem to have gotten more out of the treatment of gables than any other style of architecture.

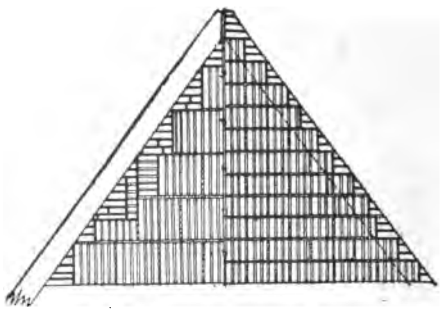


FIG. 59.—Gable Built of Hollow Tile. The Illustration Is Divided So As to Show Two Types of Construction

A gable built of hollow tile is shown in Fig. 59. This is divided in the center to show two types of construction. To the left the gable is built of full-size hollow tile blocks with brick fill. At the right the gable is built of half size hollow tile blocks and brick fill.

The rafter is shown in place to the left, while at the right the rafter is removed to show the way the walls ought to be extended clear through to the roof boards.

Of course the walls would be plastered or stuccoed, and in practice, no doubt, the gable would be relieved by some sort of window or ventilator to break up the plain surface. A window is not shown here, for all that is desired is to show how the gable of a building can be filled in with blocks of hollow tile.

CHAPTER VIII

Roofing Hollow Tile Buildings

What little thought is given to the roof of a building I mean, of course, by the average man in the building line, even those who have the building of roofs as part of their work. To most people the roof is merely a shelter from the elements. It keeps out cold and rain, snow and hail, and protects from the merciless heat of the sun in summer weather.

That of course is the function or use of a roof, but how many have thought how the function and service affect the design? Everything in building practice has a use, else it looks strange and out of place, and the 57 varieties in shape and design of roofs have been brought about by different needs in the several parts of the world. If the same conditions obtained in all parts of the world, there would never have developed in practice so many different kinds of roofs and so many varieties of detail.

In tropical climates a thatched roof fills the simple requirements of the common people. In the Arctic Circle a domed roof of ice or snow covering the iglo marks the opposite extreme. Between these two extremes can be found any modification almost that is desired. Have you ever asked yourself why a pitched roof? Why a flat roof would not serve for all purposes outside of architectural effect?

There are several reasons for the pitched roof. A

flat roof will shed water, it is true, but a pitched roof will shed it quicker and with less danger of leaking. A better and more costly covering is required on a flat roof, for an ordinary shingle roof on a flat pitch would leak like a sieve with a driving rain falling on it. Economy, then, makes a strong plea for a roof of decided pitch.

Snow is likewise a modifying element in the design of a roof. In regions where the snowfall is heavy, a pitch roof, while not an absolute necessity, is in the highest sense desirable. In such regions the roofs are made of sufficient pitch so the snow will slide off when a fall of a few inches has accumulated.

Let us see what the effect would be of a heavy fall of snow on a flat roof. Suppose, as often happens, a fall of from four to six feet of snow should accumulate on a roof, then be followed with a rain storm, the water falling on the roof being held by the snow where it might remain in a slushy condition or freeze to ice.

This would impose such a weight on the roof that it would be liable to give way, unless that excessive weight were taken into consideration by the designer, and a roof built much heavier and stronger than would be required if it were pitched. That, of course, would add to the cost, while a mass of ice on the roof of any building is not good, to say the least.

We can see, then, the necessity for a pitch roof in cold climates, but why a pitched roof in warm regions?

Protection from the elements again dictates the use of a pitched roof for economy, comfort and safety. By using a pitched roof in warm regions an air space is provided above the top floor so that the building will

be cooler in summer and warmer in winter than if a flat roof were built close to the top floor ceiling. This feature is likewise of value in cold climates, for it keeps the buildings warmer than if the roofs were flat.

The climate of a locality is the chief modifying characteristic in the design of a roof or cornice, and by climate is meant more local conditions than the temperature due to the region. For instance, in a part of the country swept by strong winds which rise at times to tornado or hurricane velocities, buildings would be designed with the narrowest cornices, the least projections consistent with good design and practice. Many buildings on or near the seashore have been unroofed or wrecked on account of a wide projection to the roof which gave the wind a good uplifting hold.

In a warm sultry region where the sun beats down unmercifully and the air seldom stirs, a great wide overhang to the roof in the form of a cornice protects the inmates just as the wide brim of a hat protects the face. A pitch roof, too, adds to the comfort of such a building, providing an air space above the living rooms, and by providing suitable ventilators to keep up a circulation of air, the building can be made quite comfortable for the occupants. While a pitch roof is desirable, it need not be a steep pitch, for no snow will fall in such a locality, or if it does, in not sufficient quantity to be dangerous. The roof, then, like all other parts of a building, is not without interest, and the methods followed in practice are not the result of accident or haphazard growth, but have had their origin in well established and good practice.

Turning now to the practical or building side of the

question, it might be well to point out that the heel of roof rafters should never be allowed to rest on top of the top tile of a wall. If the rafters were so installed there would be no support, one to another, and no cohesion between the walls and the roof. A stress at one point, then, would be liable to cave in the roof at that point instead of spreading the stress over the entire roof surface, while, on the other hand, it would be almost impossible to maintain a straight line in the cornice, which would be full of short waves, due to the unequal stresses at different parts of the roof.

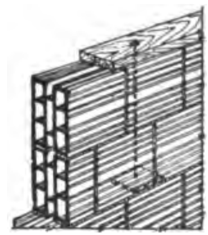


Fig. 60.—Fixing the Plate on a Hollow Tile Wall for the Rafters. The Plate Is Bolted Down As Shown

In erecting a frame building a plate is provided at the top of the bearing walls to which the rafters are spiked. In a hollow tile building a similar plate must be provided. The manner of doing this is shown in Fig. 60. Steel or iron bolts are bedded in the wall at intervals of a few feet, a plate, the full width of the wall is bored at the proper intervals to slip over the bolts, washers are dropped in place and the nuts screwed down, securing the plate firmly in place.

A section through the wall of a building showing the plate in place and a rafter resting thereon is shown in Fig. 61. It will be noticed that the floor joist or collar beams are fastened to the plate and rafter at this point. A tie beam of some kind is necessary to keep the rafters from spreading and to give stability to the top part of the wall. By tieing all the members together in this way, a plate to the wall, rafters and collar beam to the

plate and together, then the collar beams to the floor joists below, by means of partitions, it will take a strong lifting power in wind to tear the roof from the building. The following illustrations show pictorially the different

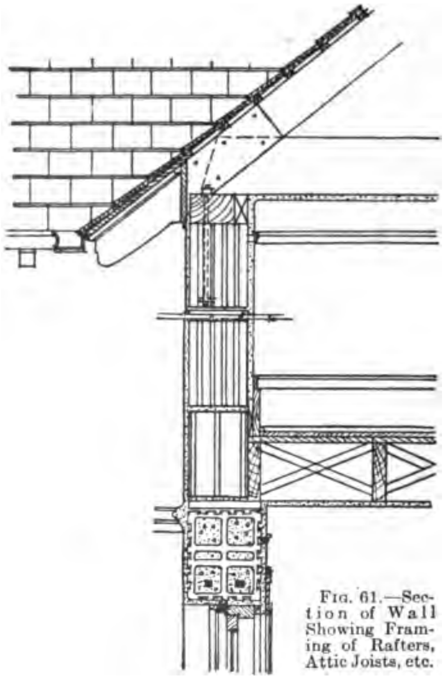


Fig. 61.—Section of Wall Showing Framing of Rafters, Attic Joists, etc.

kinds and pitches of roofs generally used with hollow tile. By studying them a mason or builder can select the style best suited to his work.

Fig. 62 is a simple pitch roof with metal eaves trough and box cornice. The box cornice makes a very neat finish. Fig. 63 shows a similar roof without box cornice

but with the ends of the rafters dressed and exposed. It may be ornamented or not as seems best with the

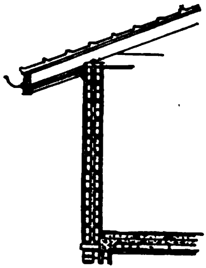


FIG. 62.—Pitch Roof with Box Cornice, the Wall Being Hollow Tile Stucco-Coated

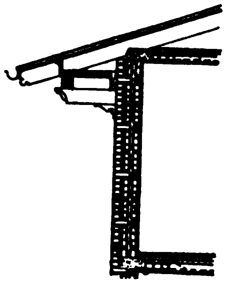


FIG. 63.—A Roof Similar to That Shown in FIG. 52, But with Slightly Different Finish of Eaves. The Wall Is Hollow Tile and Brick Veneer

brackets illustrated. Fig. 64 is a deep box cornice with large bracket supports and wooden eaves troughs.

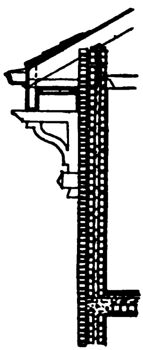


FIG. 64.—Box Cornice with Ornamental Brackets

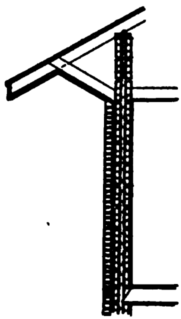


FIG. 65.—Heavy Overhang Braced with Brackets

This is a rather heavy and expensive design and not suitable for the run of buildings. Fig. 65 is an unusu-

ally large overhang well braced with rough covered brackets to the wall. It has no eaves trough or gutter, although either may be supplied. Indeed, any type of

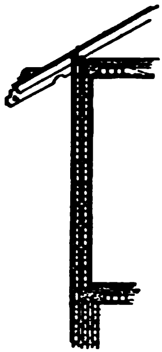


Fig. 66.—Light Roof Construction with a Type of Standing Gutter

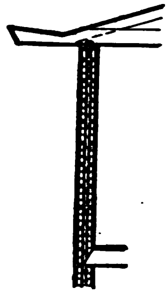


Fig. 67.—A Type of Roof Construction Where the Attic Joists Are Extended and Trimmed to Form a Gutter

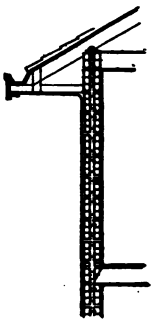


Fig. 68.—Another Type of Gutter

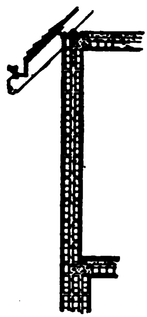


Fig. 69.—Built-in Gutter with Box Cornice

gutter or eaves trough may be used with the designs shown here.

Fig. 66 is a light roof construction with roof gutter.

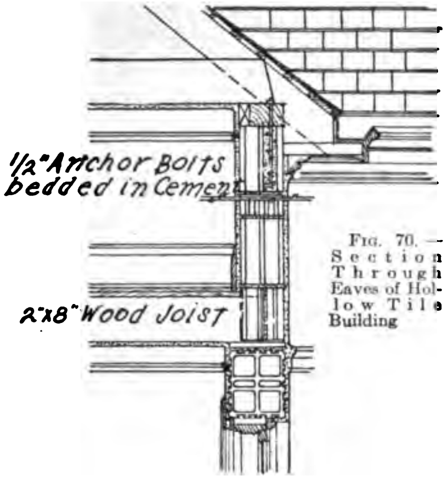


FIG. 70. — Section Through Eaves of Hollow Tile Building

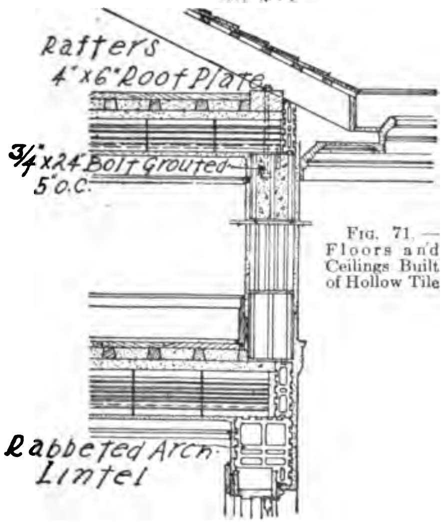


FIG. 71. — Floors and Ceilings Built of Hollow Tile

Fig. 67 introduces a new type in which the roof joists are trimmed and extended to make an overhang for the cornice, and a depression for the gutter. Fig. 68 shows a steep pitch roof with a cut-in gutter, the ends of the rafters being dressed and exposed. Fig. 69 is a built-in gutter with box cornice and large overhang.

Fig. 70 shows a section through the eaves of a building, illustrating the relation of the various parts. It

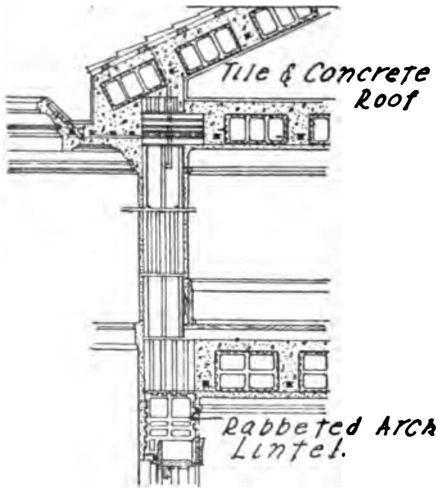


FIG. 72.—An All Tile and Concrete Roof and Gutter

will repay well a careful study. Fig. 71 shows the same type of roof but with less pitch, adapted to a building the top floor or ceiling of which is built of hollow tile blocks. Fig. 72 shows the construction of an all tile and concrete roof and gutter and gives enough detail to enable the resourceful builder to construct a similar one.

CHAPTER IX

Floors, Roofs and Bulkheads of Hollow Tile

The subject of floors, roofs and bulkheads is here treated only so far as it applies to ordinary buildings of hollow tile or brick construction having bearing walls of masonry. The use of hollow tile in connection with buildings of steel skeleton construction is so different,

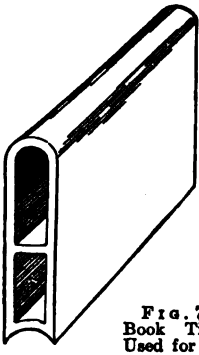


FIG. 73.—Book Tile Is Used for Roofs

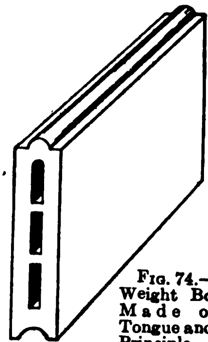


FIG. 74.—Heavy-Weight Book Tile Made on the Tongue and Groove Principle

and of so much importance in building practice that it will be considered separately.

Book Tile

For the roofs of buildings special tile blocks, known as "book tile," are made. The reason for this name will be seen by referring to Fig. 73. This shows a standard or light-weight block used for light construction where it is not necessary to sustain heavy loads.

A special shape and heavy weight block is shown in Fig. 74. This block, it will be observed, is made on the well-known tongue-and-groove principle, so that, as in the case of the standard weight tile, one block will interlock with the two adjoining blocks.

Book tile are intended primarily for the construction of pitch roofs, also for covering the flat roofs of pent-houses, tank houses or bulkheads, and may be used for the main flat roofs of buildings when the live load to be carried will be light. When providing for future increase in height of a building a floor of flat arches is usually set, the roof graded above the flat arch and supported on T iron or dwarf walls, and book tile used for the roof covering. Book tile are made especially for roofs to be covered with concrete, tar and felt, or any composition roofing material. They are made of uniformly hard burned material either 3 or 4 inches thick, and of a length depending very much on the weight to be carried. Three inches is the standard thickness for roofing tile, and 4 inches a special thickness.

For pitch roofs where roofing tile are to be used, or any other covering material which must be nailed to the supports, special tile of porous material are required. The roofing tile can then be nailed to the book tile as easily as they could to roof boards. Book tile are made both with smooth surfaces and with grooved surfaces, and the kind wanted should be stated when ordering. The grooved surface tile are for use when they are to be cemented or plastered. A roof of book tile which is to be cemented on top and plastered underneath would want book tile grooved on both sides.

Book tile may be used simply as roof tile; as combination roof and ceiling tile, or as ceiling tile when a light ceiling is to be constructed under the roof, or a false ceiling put in to mask plumbing pipes. Ceiling book tile, however, are made thinner than book tile for roofs. They may be had as thin as 2 inches, or of the regular thickness of roof tile, 3 and 4 inches; also they may be had in dense, porous and semi-porous materials.

The standard sizes and weights of book tile, both for ceiling and roof construction, can be found in the following table:

TABLE VI

STANDARD SIZES AND WEIGHTS OF BOOK TILE

Roof Tile, Inches	
3x12x18	20 pounds per square foot
3x12x20	20 pounds per square foot
3x12x24	20 pounds per square foot
4x12x24	24 pounds per square foot
Ceiling Tile, Inches	
3x12x16	20 pounds per square foot
3x12x18	20 pounds per square foot
3x12x20	20 pounds per square foot
3x12x24	20 pounds per square foot
Ceiling Tile, Inches	
2x12x16	12 pounds per square foot
2x12x18	12 pounds per square foot
2x12x20	12 pounds per square foot

When book tile are to be used for both roof and ceiling the ends of the tile are rabbeted, as shown in Fig. 75, so the under surface of the tile will extend below the under side of the flange of the T beams. Specifications or the steel framework for the roof of buildings where

book tile are to be used should call for the spacings of the T beams to be 1 inch further apart than the length of tile to be used. For instance, for tile 18 inches long the T beams should be spaced 19 inches on centers.

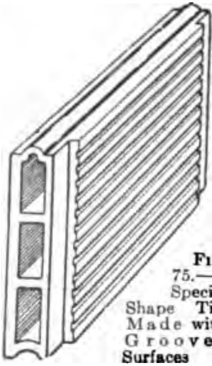


Fig. 75.—A Special Shape Tile Made with Grooved Surfaces

When the book tile are not to be plastered on the under side, or the flanges of the T beams protected, the book tile may be cut square at their ends and be laid on the flanges of the T beams. When the under side is to be plastered, the book tile are rabbeted so the bottom of the blocks will be at a lower level than the flanges, as shown in Fig. 76. If the flange of the T is narrow the plaster will cover it without trouble. If, however, the flange is of considerable width, it should be wrapped with metal lath before the tile are set. A practical, everyday use for book tile will be found in the typical bulkhead con-

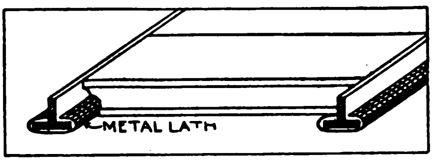


Fig. 76.—When Underside Is to Be Plastered, the Book Tile Are Rabbeted So That the Bottom of the Blocks Will Be Below the Flanges. Metal Lath Covers the Lower End of the "T" So As to Provide a Clinch for the Plaster

struction for a show window illustrated in Fig. 77. It is important that the first or ground floor of store buildings be of fireproof construction, and the building laws of most cities now require that the first floor

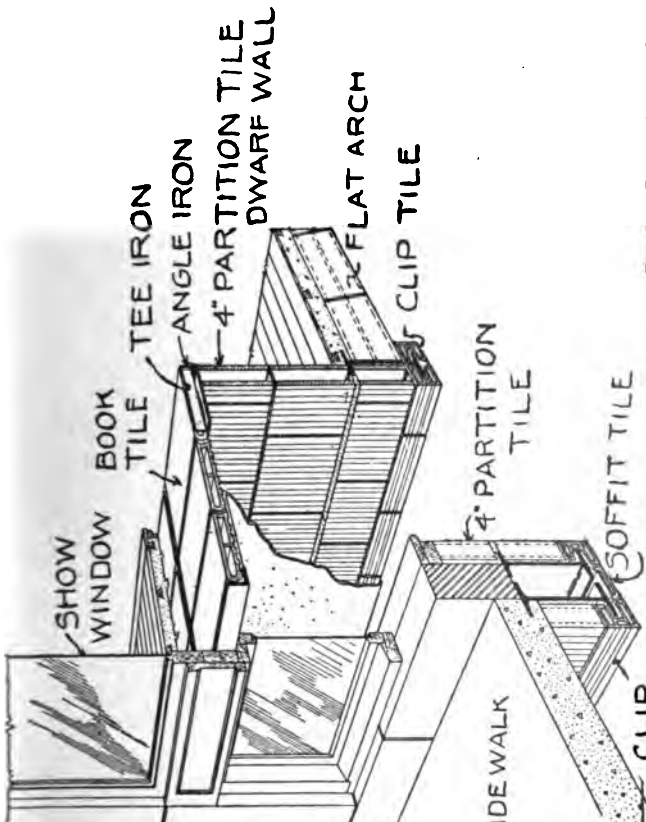


FIG. 77.—Book Tile Are Often Used For Bulkhead in Show Windows

of all buildings over four stories in height be fireproof. Fire is more liable to start in the cellar or basement of a building where the furnace is located, and once started finds plenty of rubbish to feed upon. It is a wise provision therefore, and one which has protected many merchants from being burned out.

The construction is simple. A four-inch dwarf wall of hollow tile is supported by an I-beam. This wall in turn supports an angle iron from which T irons are sprung to support the book tile. The surface of the tile can then be plastered, cemented, or given any treatment desired.

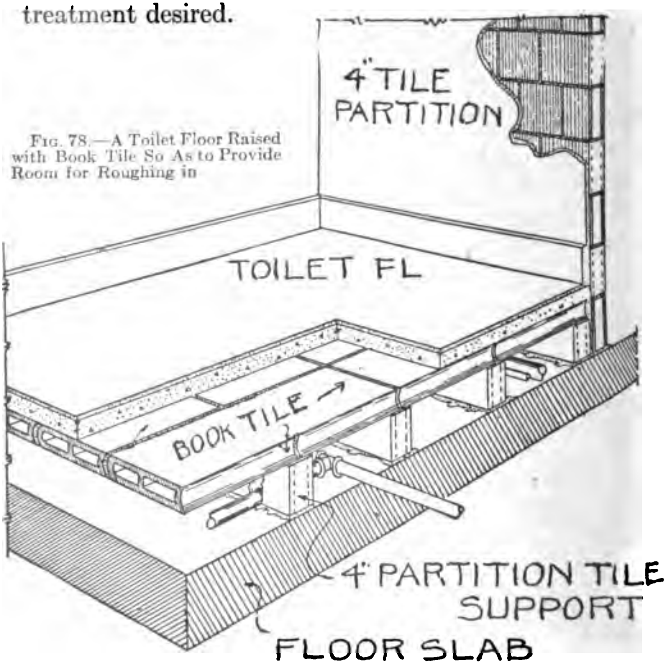


Fig. 78.—A Toilet Floor Raised with Book Tile So As to Provide Room for Roughing in

It is often necessary to raise toilet room floors in order to provide space for the roughing-in pipes of the plumbers. When that is necessary it can be done, simply, speedily, easily and economically, as shown in Fig. 78. Tee irons or metal supports of any kind are not necessary for this form of construction. Ordinary 4-inch partition tile are laid on the floor at the right distances apart to form supports for the book tile, and the tile are extended across the room to form beams. The book tile are then laid on these hollow-tile supports and the cement or tile floor laid thereon.

In case it is found more advantageous to conceal the pipes with a hanging ceiling, doing the roughing-in of the plumber's pipes below the floor, 2-inch ceiling block book tile can be used for the purpose, supporting the tile on a framework of T irons.

Hollow-tile floors for buildings having hollow-tile bearing walls are becoming more numerous each year. They are light, inexpensive, fireproof, comply with the building and fire laws, and can be laid with common labor. One view of such a floor construction can be seen in Fig. 79. In this type of floor the reinforcement is in the form of steel rods and expanded metal or wire lath, embedded in the layer of concrete on which the hollow-tile blocks rest. The tile are set with cement mortar joints and floors of this construction have been made with spans as great as 25 feet.

The construction of the wall where the floor rests upon it is worth studying closely. The top row of wall tile on which the floor is to rest is covered with a course of solid slabs. On top of these slabs the floor is rested, extending to within about 3½ inches of the outside

surface of the wall. Short 3-inch facing tile are then laid to close the end cells of the floor blocks and carry the outer portion of the wall to the level of the top of the floor. The wall is then continued upward, the first tier of blocks resting partially on the 3-inch facing tile and partly on the floor blocks. Another form of floor construction and the way the floor is laid is shown in Fig. 80. This might be called the beam and block

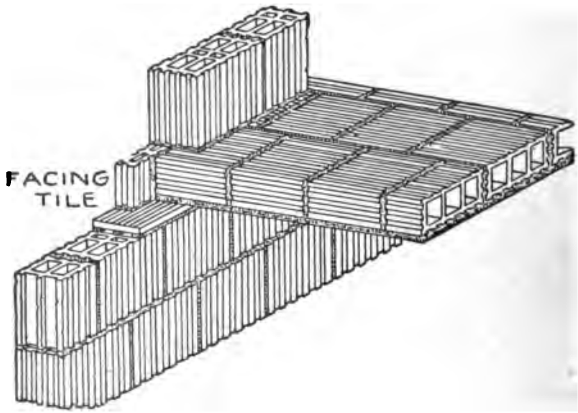


FIG. 79.—Construction of Hollow Tile Floor. Note Construction At Wall

type, for in it a concrete beam alternates with a line of hollow tile blocks. In laying this form of floor, 2-inch planks are spaced 16 inches apart or rather on centers, and the hollow tile laid end-to-end on these planks, spanning them as indicated in the illustration. The steel reinforcing rods are then put in place between the rows of hollow tile blocks, and supported a couple of inches from the planks. The floor is then ready to pour.

Floors of this type can be made to cover any span of

25 feet or less, and to support any weight of load within reason. The weight the floor must sustain per square foot of surface determines the amount of concrete and the weight of steel that will be used. It might be well to point out here that the steel reinforcing rods are bent upward near the wall supports so they will be bedded near the top portion of the concrete over the bearings.

Whether the floor is designed for heavy service or for

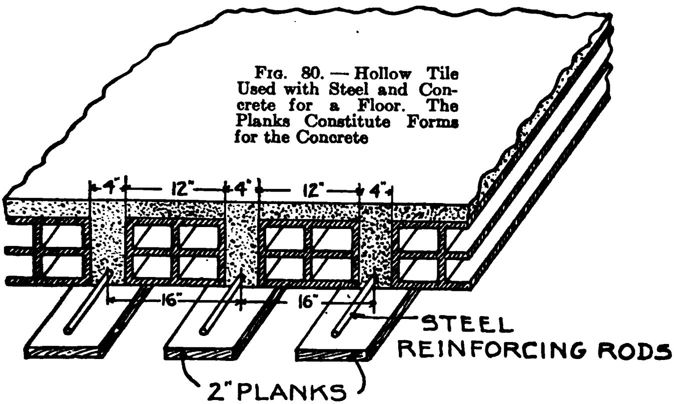


FIG. 80. — Hollow Tile Used with Steel and Concrete for a Floor. The Planks Constitute Forms for the Concrete

light loads and work will determine, too, whether or not there shall be a layer of concrete above the tile blocks, and what the thickness of this layer shall be. The floors can be laid with no concrete above the blocks. On the other hand, they are sometimes called for with cement both above, below and at the sides of the hollow tile blocks. When the blocks are to be bedded in a layer of concrete, however, whether plain or reinforced, a continuous flooring must be provided

on which it will rest. It might be well to state here to guard against misunderstanding, that if there was a layer of concrete below the hollow tile blocks it would be reinforced with steel mesh or with steel rods, otherwise it would be useless. This will be explained more fully when we take up the reinforcement of concrete with steel. It will be sufficient to state here that steel is used to provide tensile strength, and to serve its purpose must be used where the concrete will be subjected to tensile stress, or a tendency to pull it apart. In this case it would be in the concrete beneath the blocks, and the concrete would be useless there without the steel.

CHAPTER X

Fireproofing with Hollow Tile

Up to the present chapter we have been considering hollow tile primarily from the standpoint of a building material. It has another and if possible still greater value, however, and that is as a fireproofing material.

It is a fact which will bear repeating many times that there is a great difference between the properties or qualities of being non-combustible and being fireproof. Many substances which will not burn nevertheless are not fireproof, due to some other quality which they lack. Then there is a difference known in building practice between being fireproof and semi-fireproof or slow-burning in construction.

A building can be of frame construction but so protected with fireproof materials that should it catch fire it would burn very slowly. Using plasterboard for the walls and partitions of buildings, or covering the walls and partitions with wire lath and plaster, are examples in point.

Again, iron will not burn, but under a temperature comparatively low iron will soften, bend and otherwise fail, so that while non-combustible it is not fireproof, or proof against heat, which amounts to the same thing. Take for comparison the behavior of masonry piers and steel columns. Under a temperature which would destroy steel columns, the tile, brick or concrete

piers would remain practically undamaged, or at all events sufficiently strong not to fail.

A few figures will show this in its right light. Cast-iron melts at a temperature of from 1,960 to 2,500 degrees Fahr., depending upon the purity of the metal. Steel, which is a more uniform mixture, melts at a temperature of 2,520 degrees Fahr., while wrought-iron melts at the higher temperature of 2,912 degrees Fahr. But the great danger is not of the metal columns or beams melting. At a temperature of approximately 1,000 degrees Fahr. steel beams will fail under the loads they carry.

Now the significance of this lies in the fact that the temperature within a burning building ranges from normal, when the fire is started, to a temperature in excess of 1,700 degrees Fahr. when the fire is well under way, and in many cases in excess of 2,000 degrees Fahr., or just double the temperature at which steel fails from softening and bending.

Because iron and steel will fail under high temperatures is no reason why they should not be used in building construction. On the contrary, they are absolutely necessary for the construction of tall buildings, as every one knows. It is necessary, however, when iron or steel is used, to so encase it in some non-heat conducting material that the temperature of the metal will never reach as high as 1,000 degrees.

Special designs of hollow tile blocks are made for this purpose, as shown in Fig. 81. Some of the blocks are so made that they possess in themselves great strength and are used for building purposes as well as for fireproofing. Other blocks are made simply to

enclose metal members and protect them from fire. This latter kind when laid up possess only ordinary strength.

From what has already been said it will be understood there are two steps to fireproofing buildings. First, tension members of iron or steel must be provided to

Fig. 81.—Types of Hollow Tile Blocks Made Specially for Fireproofing

carry the load; and, second, those members must be protected from failure by encasing them in heat-proof materials, such, for instance, as hollow tile or concrete; and this heat insulating material must be of sufficient thickness to prevent the transmission of heat in any great quantity, as will be explained later.

The protection afforded by a good heat insulating material can be judged from the fact that exposed to a temperature which would destroy an unprotected column or beam no great rise in temperature takes place. For instance, when exposed for two hours to a temperature of 1,700 degrees in experimental tests columns and beams protected by only 2 inches of fireproofing material increased in temperature only 160 degrees Fahr.

The three grades of tile, "dense," "porous" and "semi-porous," have each their own particular field of usefulness, and one and all are used in the practice of fireproofing. Porous hollow tile is the very best from a strictly fireproof standpoint, but as it does not possess as great strength as semi-porous or dense tile it is not so suitable for arches or like construction where the blocks must be used for structural as well as for fireproofing purposes. Owing to this fact porous blocks or semi-porous blocks are generally used for the protection of columns, as covering for girders, for roofing blocks or any other place where the maximum protection is desired.

How to Build Flat Arches

One of the earliest uses to which hollow tile was put was in the construction of arches. Originally bricks were used for this purpose, but with the development and growth of tall buildings weight became a factor in design, and everything which could be eliminated to decrease weight without sacrificing strength was adopted. Hollow tile lent itself to this new type construction. Sprung between two I-beams of a building they were light, easy to lay, economical, fireproof and,

when desired, presented a flat surface for the under side or ceiling.

Hollow tile arches vary in design, covering a wide range, blocks having been made to suit any condition or requirement. There are, therefore, short-span arches

FIG. 82.—Hollow Tile Flat Arch, with Tile Laid Side to Side

and long-span arches, side-construction arches and end-construction arches, flat arches and segmental arches.

A perspective view of a flat arch, side construction, is shown in Fig. 82. In this type of construction the cells in the hollow tile blocks run longitudinally with the beams. It will be noticed that the tile are so laid

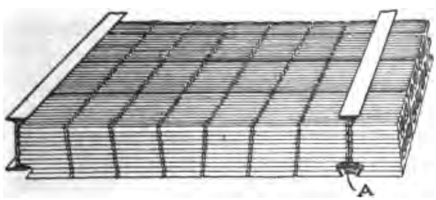


FIG. 83.—Flat Arch, End Construction. Tile Laid This Way Develop About 50 Per Cent Greater Strength Than When Laid As Shown in FIG. 82

that they break joints, a condition which obtains in no other type of flat arch. This is an advantage inasmuch as should one of the blocks fail it will not impair seriously the stability of the arch, or even of one row of tile. Notwithstanding that advantage, however, this type of

construction is not so generally used as other forms which will be illustrated and described later.

In Fig. 83 is shown a flat arch of end construction. In this type of arch block the air cells, likewise the shell and webs, run crosswise from beam to beam. This forms without exception the strongest arch of the kind made of hollow tile. It is about 50 per cent stronger than an arch of similar depth and span laid up with side construction blocks.

There is no type of construction which is perfect, so it may be inferred that there are objections to end construction arches as well as advantages. The advantages so outweigh the disadvantages, however, that end-construction tile are far more extensively used than side-construction tile, and may be considered the strongest type of arch made. In present-day practice, however, it is modified somewhat to obtain some of the advantages of side construction while retaining the greater part of the strength and most of the other advantages of end construction. This brings about a combination arch which will be described later.

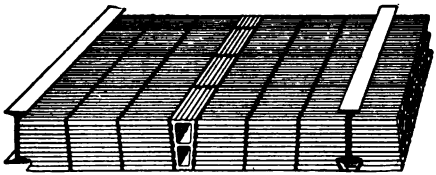


FIG. 84.—End Construction, with Side Construction for the Key Tile

It will be noticed that in the end construction the blocks are laid end-to-end and the rows stretch from beam to beam without breaking joints. It follows as a

consequence that should one of the tile be removed or become broken by a weight falling upon it, there is nothing to hold the other blocks in place but the side adhesion to the two adjoining courses. There is no danger of the arch failing on that account, it might be well to add, so that it is of little moment in practice.

In Fig. 84 an advance is made a step toward modern construction. In this arch we have the end construction for all blocks except the key tile, which are side-construction.

It might be well here to point out a few features of

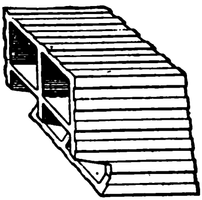


FIG. 85.—A Skew Back, or Tile Made to Fit Against the I-Beams

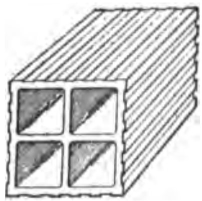


FIG. 86.—A "Lengthener," Used to Fill Out Spaces Between Skew Backs and Arch-keys

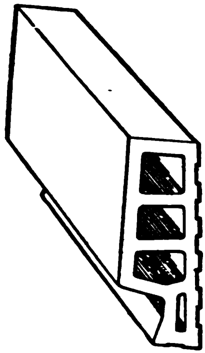
arch construction common to all types, and at the same time explain the different kinds of blocks employed in building arches and give their names.

In Fig. 85 is shown a "skew," or "skewback." This is the tile block which fits against the steel I-beams and against which the arch is sprung from beam to beam. Next comes the lengthener, Fig. 86. These are used to fill out the spaces between skews and arch keys, and the number employed in any one course will depend on the length of the span. Four lengtheners are all that are generally required for short-span arches, although

many more are required for the long-span arches later to be described.

The key block, Fig. 87, is common to all kinds of arch construction, so that its shape and function are known. It might with good reason be called a wedge block, because it is by wedging the other blocks in place that it keys them, or secures them where they belong. The

Fig. 89.—A Skew Which Is Better Than That Shown in Fig. 86 Considered from the Point of Fireproofing



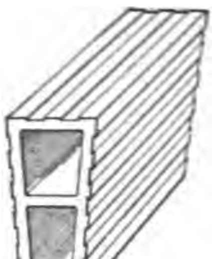


Fig. 87.—A Key Block

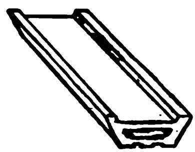


Fig. 88.—A Soffit Block, Used As Shown in Figs. 83 and 84, at A

key shown in the illustration is a side-arch block but is now used with combination arches.

A "soffit" is shown in Fig. 88 and its place in arch construction, or its application in fireproof construction, may be seen by referring back to A in Fig. 83. It is not in any sense structural in its function, nor is it a

part of the arch proper. Its entire use is in protecting the under side of the I-beam from the heat of a fire. By studying carefully the illustrations, Figs. 83 and 84, it will be seen that in spite of the trouble and expense gone to in putting in hollow tile arches, from a fireproofing standpoint it might all come to nothing if the soffits were omitted. The under rail of the I-beam is the tension member. It is here the weight superimposed on the floor tends to tear the rail or beam apart. Less heat applied here would be more dangerous than if applied to the upper rail of the beam. Once the rail reached the temperature of 1,000 degrees Fahr. it would begin to stretch, bend or sag, and the arch would go with it. It will be readily seen, therefore, that it is necessary from a strictly fireproofing standpoint to protect the under rail of the beam, and that is just what the soffit is designed for. It will be noticed that the soffit is made with an air space. In fact, with two air spaces, for the shells extending above the upper surface, form a second air space when the soffits are in place. Some soffits are made solid, but as will be demonstrated later, fireproofing with air cells offer greater protection against the transmission of heat than do solid blocks, besides being lighter to handle and easier to hold in place.

The skew shown in Fig. 85 is objectionable for the reason that if the soffit be omitted, or if it becomes broken or removed, the entire side of the I-beam, as well as its under rail, becomes exposed to the flames. Structurally it is a good strong block, but it lacks something from the fireproofing standpoint, so the weakness has been strengthened by designing the skew shown in

Fig. 89. This is a side skew strong, safe and satisfactory. It is used not only with arches of side construction, but with end construction as well, as may be seen in Fig. 90.

All of the arches shown in preceding illustrations

FIG. 90.—The Skew Shown in FIG. 89 Used in End Construction

have been more or less evolutionary in their course. As improvements either from a structural or from a fireproofing standpoint have been worked out they have been adopted, until at the present time the arch most used, and which combines the greatest number of good

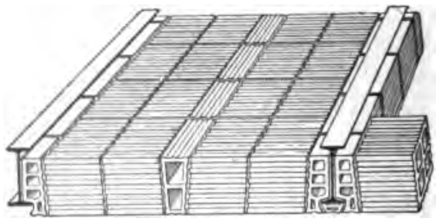


FIG. 91.—Combination of End and Side Construction, the Type of Flat Hollow Tile Arch Most Used To-day

points, is a combination of end and side construction flat arch, similar to that shown in Fig. 91. In this combination the skews and key blocks are all side construction, while the lengtheners are of end construction. This arch represents the maximum of strength, lightness and safety, all combined in one.

To the casual observer, hollow tile arches seem lacking in strength on account of the cellular structure of the blocks. It is generally a surprise even to experienced builders who have done but little fireproofing work to know what they will stand.

Strength of Flat Arches

The following table will give an idea of what can be expected of flat arches of short spans built of blocks of different depths. The weights of the arches have not been deducted from the safe loads in this table, therefore the weight of the arch must be deducted to obtain the net safe live load for any arch and span.

The depth of the arch must be proportioned to the span between beams, and to a certain extent to the load to be carried. The spans given and the loads the arches will carry, as listed in the table, will be found perfectly safe, as they possess a factor of seven.

A couple of facts about the strength of arches it will be well to keep in mind when designing hollow tile floors are the effect on the strength of an arch of the depth and span. For instance, doubling the length of span, the depth and weight of block remaining unchanged, will reduce its strength, not one-half, but to one-quarter of that of the shorter span. Conversely, reducing the length of span by one-half multiplies the safe load it will sustain, not by two, but by four.

Increasing the depth of an arch strengthens it in even greater proportion. For instance, adding one inch in depth to a 6-inch arch will increase its weight-bearing capacity on an average about 150 pounds per square

foot; while doubling the depth of an arch multiplies its strength by more than three.

TABLE VII

SAFE LOADS—(DEAD AND LIVE)

Factor of Safety of 7

Arches	6 In.	7 In.	8 In.	9 In.	10 In.	12 In.	15 In.
Average Weight per Sq. Ft.	26	29	32	35	38	42	50
Spans, Ft. and In.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
3–0	482	617	767	933	1114	1524	2255
3–3	410	525	654	795	950	1299	1922
3–6	354	453	563	685	819	1120	1657
3–9	308	394	491	597	713	975	1443
4–0	271	347	431	525	627	857	1268
4–3	240	307	382	465	555	759	1124
4–6	214	274	341	414	495	677	1002
4–9	192	246	306	372	444	608	900
5–0	173	222	276	336	401	548	812
5–3	...	201	250	304	364	497	736
5–6	...	183	228	277	331	453	671
5–9	...	168	208	254	303	415	614
6–0	...	...	191	233	278	381	563
6–3	...	...	176	215	256	351	519
6–6	...	...	163	198	237	324	480
6–9	...	...	...	184	220	301	445
7–0	...	...	...	171	204	280	414
7–6	...	...	...	...	178	243	360
8–0	...	...	...	...	...	214	317
8–6	...	...	...	...	...	190	281
9–0	...	...	...	...	...	169	250
9–6	...	...	...	...	...	...	225
10–0	...	...	...	...	...	...	203

When a cinder fill is laid above a flat arch, the weight of cinders and fill must be deducted from the safe bearing strength of the arch. In order to find what the

permissible live load should be the way to figure the safe load of an arch can be found by studying the following example:

Example: What load will an 8-inch arch carry with a factor of safety of 5, in a span of 5 feet 6 inches, the arch having a weight of 36 pounds per square foot?

Solution: In the table an 8-inch arch has a strength of 228 pounds for a weight of 32 pounds. Therefore, $32:36 = 228:256$, and $256 \times 7 + 5 = 358$ pounds total load. $358 - 36$ pounds dead load $= 322$ pounds live load, which must be further reduced by the weight of fill over the arch, finished flooring and plastering to get the new safe live load.

For practical building construction it will be well to bear in mind that the deeper the tile, within reasonable limits, the stronger the arch will be, and for the same depth of beam the lighter and cheaper will be the floor construction. For instance, a 12-inch hollow tile arch will weigh less per square foot than a 10-inch hollow tile arch with 2 inches of concrete fill, and the 12-inch arch will cost less than the 10-inch arch and 2-inch cinder fill.

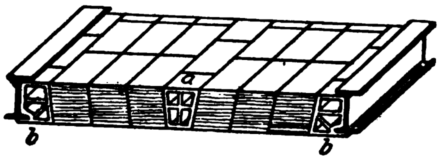
The depth of arch required for any span, whether for side construction, end construction or combination side and end construction, can easily be found by means of the following simple rule:

Rule: To find the depth required for a hollow tile flat arch of short span, multiply the width of the span in feet by 1¼ and add the projection of the tile in inches below the ceiling beams.

Example: Find the depth of hollow tile arch required for an 8-foot span when the skewbacks project 2 inches below the I-beams.

Solution: $-8 \times 1\frac{1}{4} = 10 + 2 = 12$ inches. Answer.

The tops of the key blocks, *a*, and that portion of the skewbacks, *b*, which rests against the lower flange of the I-beams, as indicated in Fig. 92, are the two points of a



FID. 92.—A and B Are the Places Where Greatest Pressure Occurs in an Arch. The Tile At These Places Should Be Well Strengthned by Reinforcing Webs

flat arch which are subject to the greatest pressure. It is advisable in practice, therefore, to see that the hollow tile blocks are well reinforced at these points by means of reinforcing webs or special construction of the shell, otherwise the arches are liable to fail under extra heavy loads.

CHAPTER XI

Reinforced Flat Arches

Reinforcement by means of steel rods and wire trusses has become so common in building practice within recent years that it is not surprising to find it resorted to in the building of hollow tile arches.

In Fig. 93 is shown a reinforced flat arch of short span. The arch in this case is of the end construction

FIG. 93.—Reinforcing a Flat Arch. The Wire Trusses Are Placed Between Each Course

type, and the reinforcement consists of special wire trusses placed between the rows of blocks. The wire trusses are protected both from fire and rust by bedding them in cement mortar.

This type of arch is intended for use where a light, cheap, but strong, fireproof floor construction, with a flat ceiling, is required. It is particularly suitable for wide spans in shallow beams. Six-inch arches for 6-foot spans, and 8-inch arches for 7 foot 6-inch spans, may safely be accepted for live loads of 150 pounds per square foot.

The wire truss reinforcement used with this type of floor construction is shown in Fig. 94. It is shipped to the building in reels, and is cut to the proper length on the job as required, so there is no delay in getting the proper lengths. The open work construction of the steel wire truss enables the mortar to flow freely all

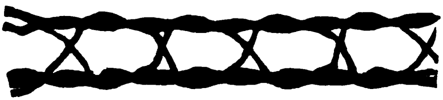


FIG. 94.—Type of Wire Truss Reinforcement Used in Building Hollow Tile Arches. The Wire Is Shipped in Rolls, and Cut As Used

about it; the joint can be thoroughly filled between the tile, and the wire is perfectly embedded in Portland cement mortar, the best rust preventive available in building practice.

In Fig. 95 is shown one form of construction to use

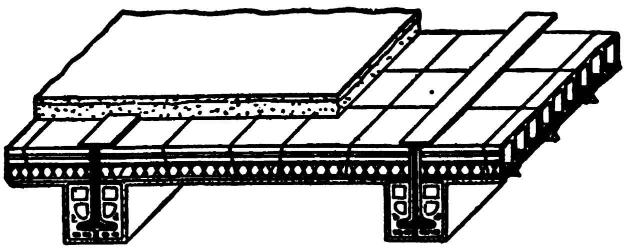


FIG. 95.—When Light Floors with Deep Beams Are Necessary, This Type of Construction Is Good

where light floors with deep beams are necessary. A paneled effect with beamed ceiling is thus secured. It will be noticed that the arch is carried on a couple of rows of special skews which rest on the lower flange of the I-beams. The thrust of the arch in that case is against the web of the I-beams, while the weight of the

arch rests on the skewbacks, which in turn are carried on the lower flanges of the beams.

Specially constructed and extra strong skewbacks, Fig. 96, are used for this form of construction, and a reinforcing web, *a*, carries the load well over on the flange of the I-beam toward the web. The entire lower portion of the skewback could be broken away and owing to this web the strength of the arch would not be weakened materially, although exposure of the lower flange of the I-beam would jeopardize this portion of the floor in case of fire.

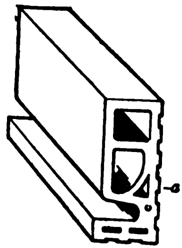


FIG. 96.—Extra Heavy Skewback

When a flat ceiling is desired in connection with this type of construction, it can be had by means of a hanging metal lath and plaster ceiling, as shown in Fig. 97. The hanging

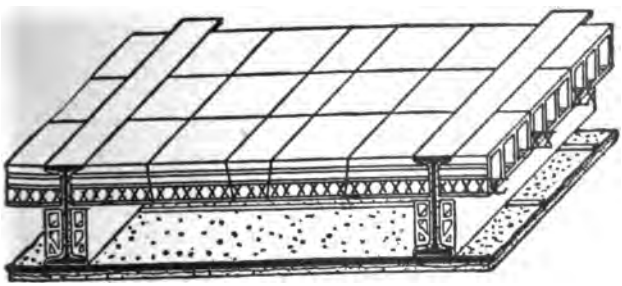


FIG. 97.—A Hanging Ceiling Used in Connection with the Arch Shown in FIG. 95. Rods or Channels Are Carried Across the Arch, Spaced According to Span and Kind of Lath Used for Plastering. Metal Lath Is Fastened to These Cross Bars By Wires or Special Clips

of a wire lath ceiling is an art in itself worthy of an entire story, but as it is not part of the subject under consideration will not be treated here.

A 6-inch flat arch reinforced with wire truss weighs only 26 pounds per square foot. An 8-inch arch of like construction weighs only 32 pounds per square foot. Such extremely light floors make it possible to effect large savings in the steel skeletons of buildings, and at the same time carry loads far in excess of what would be imposed in apartment houses, hotels, office buildings and loft buildings for light manufacturing purposes. Load tests made to determine the ultimate strength of a 6-foot span showed that the weight under which it failed was 1,600 pounds per square foot. This gives a safe live load of over 250 pounds per square foot with a factor of safety of six. It will be remembered, however, that the safe live load an arch will support includes the weight of the arch itself, the fill and flooring above. In this case the arch tile weighs 26 pounds per square foot. On top of arch tile is generally placed a few inches in depth of cinder concrete, and on top of the concrete a wood or cement floor. It is safe to figure, therefore, that the weight of the floor and arch construction is 50 pounds per square foot, and this amount must be deducted from the safe live load the arch is designed to carry. In the case of a 6-inch arch this would be 250 pounds less 50 pounds, or 200 pounds net safe live weight the construction will carry.

Comparison sometimes serves to show the relation between parts and the strength of different structures used for the same purpose. It shall now be used to show the saving in space, weight and money effected by reinforcing an arch. For an ordinary arch, a span of 6 feet requires a depth of 8 or 9 inches; while if the arch is reinforced, the depth for a 6-foot span need be

only 6 inches. The weight of 6-inch tile is 26 pounds per square foot. The weight of 9-inch tile is 35 pounds per square foot. The difference in weight between the two constructions is 9 pounds per square foot.

Let us assume a building 100 feet square and ten stories high. The difference in weight would then be 900,000 pounds, or 450 short tons, which would be equal to 45 tons on each floor of the building.

Height is another element in building which must be considered, for the higher the walls and floors go the more expensive it is to build them. A 6-inch tile arch saves three inches at each floor over a 9-inch tile arch; and in a building ten stories high the difference would be 30 inches.

A saving of 30 inches of wall and partition; a saving of 45 tons of tile to each floor, and the saving effected in the lighter steel construction required ought to appeal to every practical builder and show the advantage to be gained by studying intimately the strong and weak points of every type of hollow tile constructure on the market.

Short and Long Span Segmental Arches

Almost any type of hollow tile arch is strong enough for general purposes, but when real strength is wanted in floor construction, the segmental arch cannot be beaten. It is the pioneer arch from which all others have been evolved, and while many different kinds have been designed displacing the segmental arch for most purposes, still when extremely heavy floor loads must be carried, as, for instance, in factories, loft build-

ings, sidewalk construction and bridges, the engineer goes back to the segmental type of arch.

The segmental arch is not only the strongest but it is likewise the cheapest known form of arch construction for any given bearing load. In view of the fact that it is not only the strongest but the cheapest arch, it might not be without interest to inquire why it should have been displaced by the flat arch.

If strength and cheapness were all that were required, the segmental arch would not have been displaced as it has been to a great extent by the flat arch. The truth of the matter is, finish or appearance is the determining factor, as it always will be in building construction, all other properties of a material or method having to give way to the quest for the pleasing, the beautiful.

In office buildings, apartment houses, hotels, clubs, public buildings of all kinds and residences, something more than an arch is needed. What is wanted is a floor construction, and the segmental arch falls short of filling the specification for that requirement. A flat arch presents a flat ceiling surface. When segmental arches are sprung, a ceiling of metal lath and plaster must be provided to give the same smooth, continuous under surface, and the cost of that ceiling must be added to the cost of the arches to find the cost of the floor construction.

The combined cost of arch and ceiling would probably equal if it did not exceed that of a flat arch, so strength is the only remaining factor in a segmental arch where flat ceilings are desired. In warehouses and other buildings where strength and cheapness are the ruling factors the segmental arch stands alone.

A typical segmental arch of hollow tile is shown in Fig. 98. It will be observed that the skewbacks butting against the I-beams have lips which project half way across the under flange of the beams. When an arch is sprung on the other side of either one of these I-beams, the two projecting lips of the skewbacks meet in the center, thereby providing cover and protection for the lower flange.

Six and 8-inch hollow tile blocks are generally used for segmental arches. Six-inch blocks are used for general purposes, and an arch of 6-inch blocks is as strong as one of 8-inch blocks of equal rise and thickness

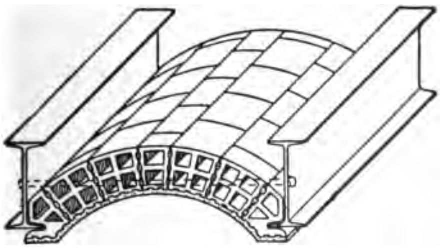


FIG. 98.—Typical Segmental Arch. Note the Lips of the Skewbacks

of web comparative to the depth of the tile. End construction segmental arches are unsatisfactory unless the arches are of uniform span and rise throughout. On the other hand, a slight variation in the rise or span does not matter in the case of side construction, for the rise can be increased or diminished by varying the thickness of the mortar of the upper or lower part of the mortar joint, and the span can be varied by varying the general thickness of the mortar joints. This cannot be done with end construction blocks.

A simple arch of hollow tile with a flat ceiling of wire

lath or expanded metal and plaster can be seen in Fig. 99. It will be noticed with this form of construction that there is no lip to the skewbacks, so the only protection to the I-beams is that afforded by the metal lath and plaster ceiling.

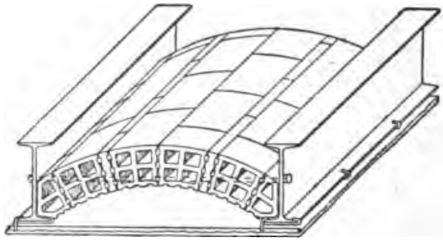


FIG. 99.—Form of Construction Where Ceiling Is Required

In places where very valuable materials are stored and greater protection is required for the I-beams, it is provided by constructing a ceiling across the under side

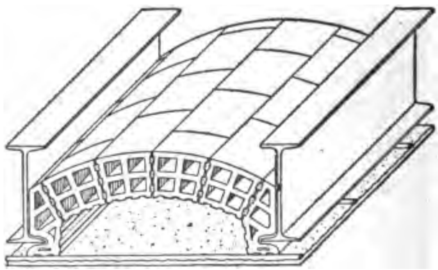


FIG. 100.—Tile Are Lipped So Entire Ceiling Can Be Torn Away and Yet the I-Beams Will Be Adequately Fireproofed

of the beams, and at the same time using lipped skewbacks similar to those shown in Fig. 98, which will continue to protect the steel beams even should the ceiling be torn away. This form of construction is shown in Fig. 100.

The rise of a segmental arch is a very important matter in practice, for within reasonable limits the greater the rise of an arch the greater the strength. It is impossible to give any great depth to an arch, however, without increasing the depth of the beams in like proportion, thereby increasing the cost. As it works out in practice, the rise of the soffit of a short-span segmental arch above the springing line is from one-tenth to one-eighth the span of the arch. Assuming the proportions to be one-tenth, a 6-foot arch would require a rise of 7.2 inches; while if the rise is to be one-eighth

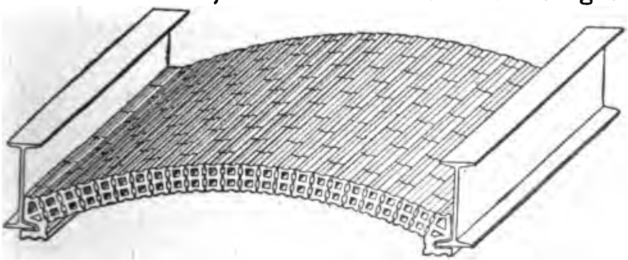


FIG. 101.—A Single Rowlock Arch Made of Hollow Brick, Which Is Very Similar to One Laid Up of Hollow Tile

of span, for a 6-foot arch it would be 9 inches. The range in height found suitable in practice, therefore, for a 6-foot arch is 1.8 inches.

The greater the rise of an arch the less will be the thrust, a fact well worth knowing and considering when the load the floor must support will be heavy.

In Fig. 101 is shown a single rowlock arch made of hollow brick instead of hollow tile. There is no great difference between hollow tile and hollow brick, the size alone being the main distinguishing feature. A double rowlock segmental arch is shown in Fig. 102. This

makes a particularly good construction for driveways, bridges or wherever heavily loaded trucks will be driven over them, or they will be subjected to unusually heavy usage.

Arches of double rowlock hollow brick will be of interest to the practical builder only where the loads

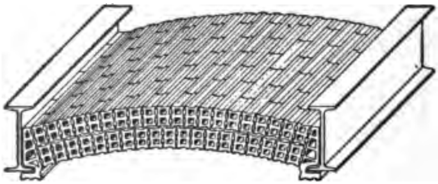


FIG. 102.—Double Rowlock Arch with Lipped Skewbacks

will be heavy. Where the loads will not be excessive, the ordinary segmental arch of hollow tile will prove the better, as it is sufficiently strong, and being much lighter, a lighter I-beam can be used. In the illustration, Fig. 100, can be seen a single rowlock arch sprung from a higher line than that in Fig. 101. That is a raised arch, and raising it has both its advantages and

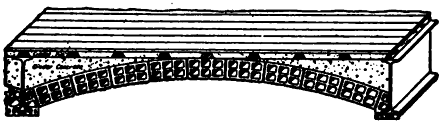


FIG. 103.—Long Span Segmental Arch. Extra Deep I-Beams Are Required with This Arch

its disadvantages. By raising the arches at the skewbacks the arches are flattened and the strength of the arch is reduced. On the other hand, the advantages gained are that it reduces the dead weight of the cinder concrete at the haunches used for beam filling, and gives a more pleasing beamed ceiling effect to the rooms.

In all arches, flat or segmental, short-span or long-span, in which a thrust is exerted against the beams, tie-rods must be provided to prevent the beams from spreading. The thrust of segmental arches is considerable, the total thrust, of course, depending on the load; and the line of thrust is about the center of the skew-backs.

Tie Rods for Arches

On account of the thrust of an arch being about the center of the skews, that would be the most effective place to locate the tie-rods to counteract the thrust near the bottom of the beams. They may be placed there and protected. That is sometimes done; or, they may be placed there and painted, but that exposes them to the heat of a fire, and if the fire is a severe one, may cause the failure of the arch. It is the practice in general, therefore, to locate tie-rods at a higher level than the center of the skews, where, while they might not be so effective in resisting the thrust of the arch, they will be protected by the arch from the heat of a fire. In flat arch construction the thrust is at the top of the keys and bottom of the skewbacks. In shallow arches the tie-rods are sometimes above hollow tile, while in deeper arches they are bedded in the arches.

The rods are usually ¾ or ⅞ inches in diameter for short-span arches. Interior flat tile arches with spans 6 feet or less generally have ¾-inch tie-rods, which are spaced about 5 feet apart. For spans of 7 feet, ⅞-inch tie-rods are used spaced 5 feet apart. When the span is greater, instead of increasing the size of the tie-rods, their number is increased and they are spaced closer

together. For instance, for a 9-foot span ⅞-inch rods would be used, but they would be spaced about 4 feet apart.

Tie-rods are seldom spaced closer than 4 feet or more than 8 feet apart. Usually they are spaced a distance equal to eight times the depth of the beam. For instance, with a 6-inch beam the tie-rods would be spaced $6 \times 8 = 48$ inches, or 4 feet apart.

The safe loads in pounds per square foot for 6-inch and 8-inch segmental arches of hollow tile built of semi-porous tile ⅝-inch webs and shells, the arches being of the side arch construction and with a rise of one-eighth, the span can be found in the following table:

TABLE VIII

SAFE LOADS FOR SEGMENTAL ARCHES OF HOLLOW TILE

Span in Feet	Safe Load for 6-Inch Arch, Pounds per Square Foot	Safe Load for 8-Inch Arch, Pounds per Square Foot
4	1,103	1,318
5	878	1,049
6	735	883
7	630	735
8	554	662
9	490	585
10	443	529

Within recent years there has been developed in practice what is known as the long span arch. These arches are used for floor construction, and will span

spaces 20 or 24 feet across. The long-span floor arch construction is the logical result of the effort to cut down the amount of structural steel required in a building, without reducing the strength of the structure. It will be readily understood by the practical builder that the less the dead weight of the floor, the less will be the size, weight and expense of columns, girders and the general building structure.

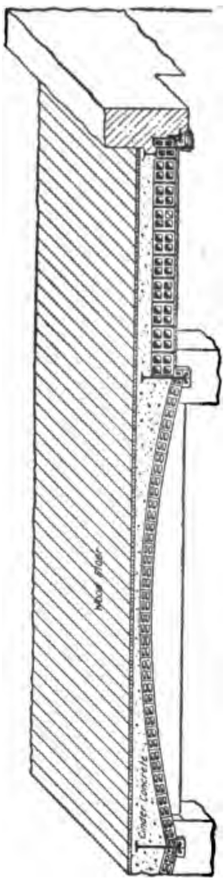


Fig. 104.—Occasional Construction of Long Span Arch At Outer Bays, to Avoid Thrust on Outer Walls

In Fig. 103 is shown detail of a long-span segmental arch. It will be noticed that extra deep I-beams must be used with this form of construction, not only to allow for the rise of the arch, but likewise to provide the necessary strength to carry the load. Segmental arches of this type have been successfully used for all lengths of span up to and including 25 feet. These arches are exceptionally strong, so strong in fact that the most concern in using them is caused by the great thrust upon the supporting beams between which the arches are sprung.

Fig. 104 is shown the way floors built of long-span arches are constructed at the outer bays sometimes, to

withstand the thrust that would otherwise be exerted near the outer walls. The outer row of bays all around the building is built of reinforced flat arches and no tie rods are used. In other installations the thrust is taken care of by steel tie rods from beam to beam built in the outer bays.

CHAPTER XII

Construction of Combination Floors

Closely akin to flat arches, but not in the true sense of the word arches, are combination floors of hollow tile and reinforced concrete. The reinforced flat arches shown in Figs. 95 and 96 are the missing links between a flat arch of hollow tile and a combination floor of hollow tile and concrete. In the reinforced flat arch wire truss reinforcement is used, but just enough cement mortar is employed to embed the

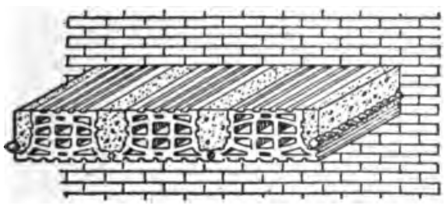


Fig. 105.—Combination Floor of Hollow Tile, Reinforcing Bars and Concrete Beams, Forming a Built-Up Floor Slab. There Is No Thrust to This Type of Floor

reinforcement and make a good joint between the blocks. In the combination floors of hollow tile and concrete we have hollow tile blocks, reinforcing bars or members of steel and concrete beams.

One form of floor construction which combines all these elements is shown in Fig. 105. A study of the illustration will show that when finished this floor presents a flat ceiling underneath and a flat floor surface

above, well keyed for a cement or tile floor if such is to be laid, or ready for wooden floor sleepers if wood is to be the finish.

This combination of hollow tile, steel and concrete is not an arch, but a big built-up floor slab which may either rest on masonry walls or be supported by means of steel I-beams. One characteristic of an arch is that it exerts a thrust on the abutments; there are no abutments for this form of construction, and no thrust. The slab rests on end supports just as a plank would, and in design must be treated more as a beam than as an arch.

Another characteristic of an arch, whether flat or segmental, is that it must be keyed. Remove the key from an arch and it will fail. There is no hollow tile block, or row of blocks, in this floor slab, the removal of which would cause the floor to fail.

The strength of the slab lies in the reinforced concrete beams, and the tensile strength of the beams depends upon the steel rods embedded in the bottom of the concrete just above the lower member of the tile. The steel reinforcing rods must be long enough to extend continuously from one bearing to the other, otherwise the floor will fail.

A combination floor of this kind is very easy to lay, and can be put in without the least trouble even by the inexperienced. A falsework of planks is first erected, on which is laid the tile in the places and positions they will finally occupy. The reinforcing rods are then very carefully put in place, the ends bent upwards toward the top of the slab, and held in that position. The crete is then poured and the centering left in place

until the concrete has had at least the initial set, and preferably until it has had its final set.

An entire room ceiling can be constructed in one span with a combination floor of this kind, which makes it a very good form of construction for tiers of toilet rooms which are located one above another.

In Fig. 106 is shown a different form of construction, but built upon exactly the same principle. The method of erecting is similar to that of Fig. 105, except that the design of hollow tile blocks differs, and the floor requires somewhat more concrete filling. The steel reinforce-

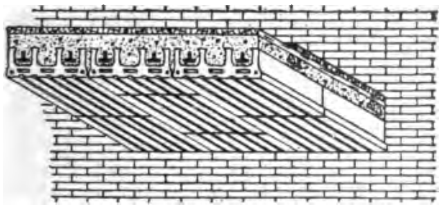


Fig. 106.—Another Type of Combination Floor. Here, as in Fig. 105, Special Tile Are Required

ment, too, is different, T-irons being used instead of plain or twisted steel rods. No cement concrete shows through the joints of either of these arches, so they can be used, as they are without finish, in loft and factory buildings, a coat of whitewash being all that is required. Blocks for these arches are made up with depths of 4, 6, 8, 10 and 12 inches.

In the two preceding illustrations special blocks of hollow tile are used. In the construction shown in Fig. 107 common, ordinary, every-day hollow tile blocks are all that are required. This floor is a com-

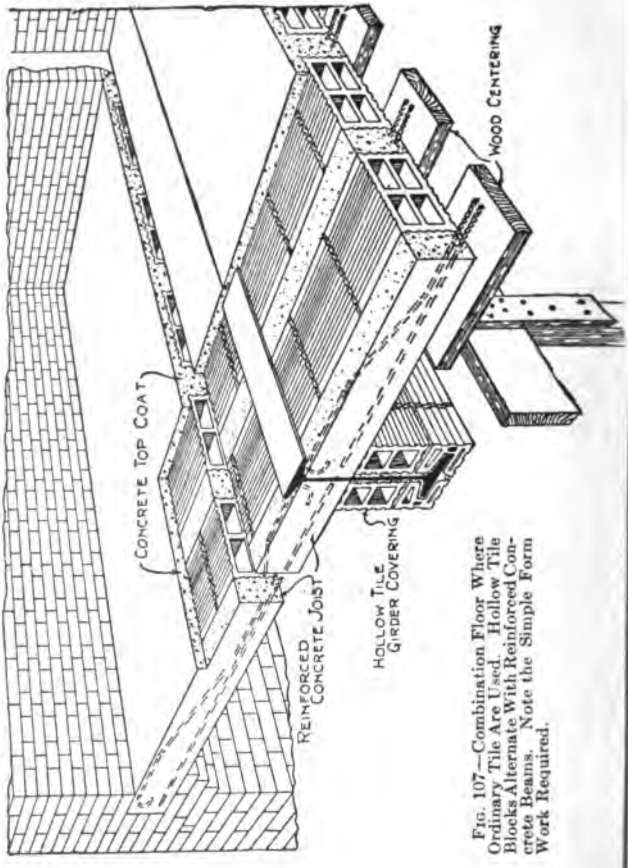


Fig. 107.—Combination Floor Where Ordinary Tile Are Used. Hollow Tile Blocks Alternate With Reinforced Concrete Beams. Note the Simple Form Work Required.

bination of hollow tile blocks laid in courses between beams or joists of reinforced concrete.

A great deal can be learned by a study of this illustration. In the first place it shows the practical builder how the wood centering to support the floor should be placed. It is not necessary to cover with planking the entire space to be floored, but just place a plank where a concrete beam will be poured.

Forms for Concrete

The simplicity and economy of forms will also be appreciated by those who know the cost of building reinforced beams or girders, on account of the carpenter work involved. In this construction one plank of wood centering serves in the double capacity of centering and form bottom. The two adjacent rows of hollow tile blocks then serve as the sides of the form, so all that is necessary is to place the steel reinforcing in position, pour the beams, wait for them to set and remove the wood centering, when you have a completed floor of great strength and lightness.

It is customary with floors of this kind to lay a top coat of cement concrete. This top coat of concrete not only serves as a finished floor, but adds greatly to the strength of the construction. Two inches is the usual depth of concrete for this top coat of concrete.

Reinforcing Concrete Beams

The method of reinforcing the concrete beams is shown in dotted lines. Twisted steel is shown in the illustration, but square steel, round rods, lug-rods or any other kind of reinforcement can be used for this

purpose. Two rods are used for each beam. One rod is carried straight across near the bottom of the beam and to a secure bearing at each end. The other rod is carried across the bottom of the beam at the same level, but is bent up as it approaches the ends to near the top of the beam, and terminates in a downward curved hook.

The slab-like construction rather than arch construction can also be seen. One end of the slab rests—does not butt against—the brick wall, while the other is carried on hollow tile girder coverings supported by the lower flange of the steel girder.

A modification of the floor construction shown in Fig. 107 is illustrated in Fig. 108. The wood centering for this is the same as for the former slab, but the hollow tile blocks are so formed that the lower shells meet under the reinforced concrete beams, so that no concrete shows in the ceiling. The shells of the hollow tile blocks are thicker in this type, and the cells are oval, one cell alone taking the place of four cells and cross webs in the ordinary type of blocks.

Less concrete is required for this type of combination floor, for the beams are only about one-third the size, and do not extend clear through to the centering. What they lack in concrete, however, they make up in reinforcement, three steel rods instead of two being used, one of which is carried across the steel I-beams.

Instead of hollow tile girder coverings the steel I-beam is bedded in concrete, the support thus formed becoming an integral part of and bearing for the joists.

Instead of concrete top coat in this case, the slab is intended for wooden floor covering. To this end wooden

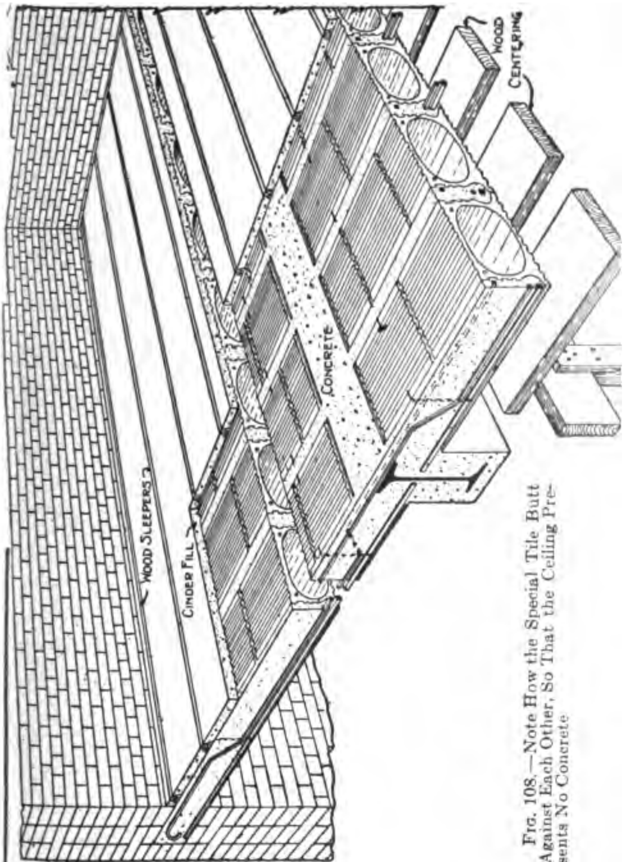


FIG. 108.—Note How the Special Tile Butt Against Each Other, So That the Ceiling Presents No Concrete

sleepers are bedded in cinder concrete fill, and the wooden sleepers are beveled to key them into the cement, thus holding them securely dove-tailed in place. Steel hangers are provided with the reinforcement, to hold the reinforcing rods the right distance from the bottom of the tile forms so they will be properly spaced to develop the greatest strength in the beams.

In Fig. 109 is shown still another modification of Fig. 107, in which the beams are smaller and the tensile strength of the ceiling instead of being in the beams or joists is contained in a thin slab of concrete which forms the entire under side of the floor construction. The thin under-slab is doubly reinforced. In the first place, steel rods extend longitudinally from bearing to bearing, and they may be bent up at the ends where they come between courses. Then a wire mesh covers the entire surface of the floor slab, adding its strength to that of the steel rods.

It might be well to add that the methods shown in the illustration are given as suggestions more than as set types. Any combination of the three methods shown may be used within reason, the object being in each case to get a good fireproof construction, economical to install, and strong enough to carry the loads to which it will be subjected in use. It might be well to again state and emphasize the fact that none of the floors shown in this installment are arches. In many ways they are simpler and better than arches, but they are not arches.

One feature of combination floor construction which recommended them to favor was the fact that they

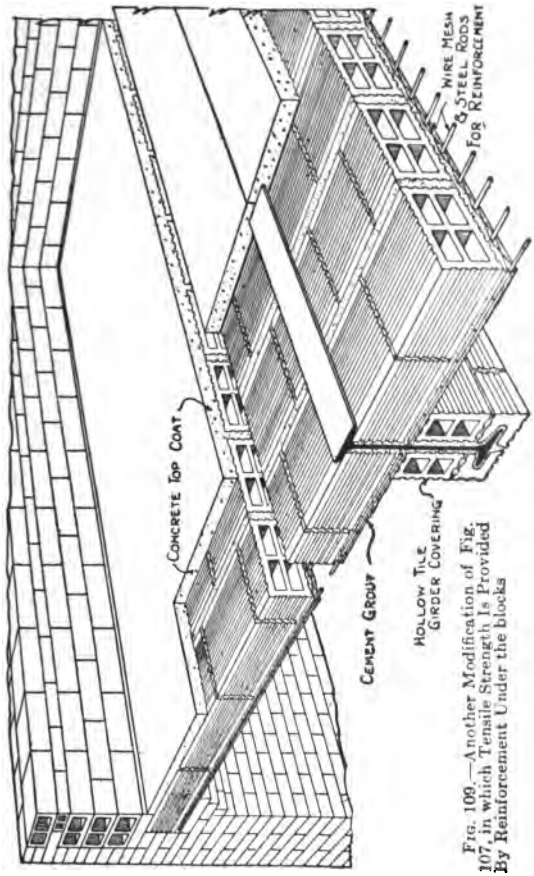


Fig. 109.—Another Modification of Fig. 107, in which Tensile Strength Is Provided By Reinforcement Under the blocks

would span large openings and present flat surfaces. That was a distinct advantage over the old-type arch construction, but recent improvements in arch construction have overcome that lead. Larger openings can now be spanned economically by means of long-span arches than by combination floors. Nevertheless combination floors of hollow tile and reinforced concrete fill a perfectly useful niche in building practice, and their use is constantly increasing as their economy and value are becoming more widely known.

In Fig. 110 is shown a form of floor construction which is unique in the fact that while it is a combination hollow tile and reinforced concrete type, the arch principle is used, not to support the floor as a whole, but inlaid so as to form a series of beams and bays. A study of the illustration will show that one of its distinguishing features is, in addition to the longitudinal beams, cross beams of reinforced concrete which divide the floor up into a number of squares. So independent are the beams of the hollow tile, other than as fillers, that the beams could be poured first and the tile set afterwards. For convenience in construction, however, the tile are set in place, the reinforcing set and the concrete poured. It will be noticed that there is a key tile, *a*, to each one of these squares, and that if these keys were removed the tile portion would fail. Also, the tile are held in place by the pressure of these keys thrusting the skews against the sides of the concrete beams, both of which characteristics stamp the construction as that of an arch.

In this two-way system the beams extend across both the short and the long span, carrying the load to

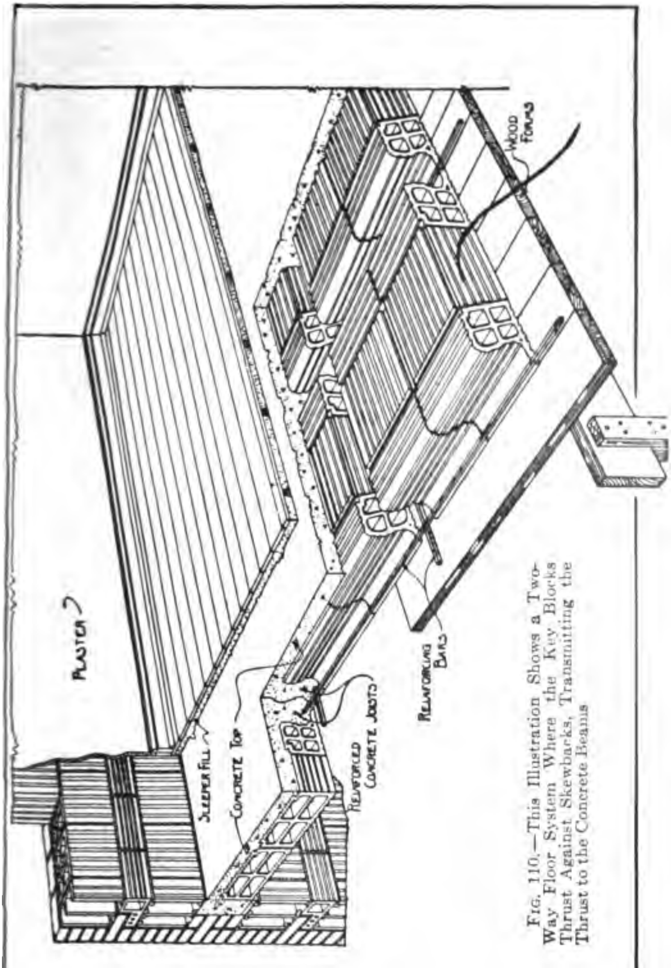


FIG. 110.—This Illustration Shows a Two-Way Floor System Where the Key Blocks Thrust Against Skewbacks, Transmitting the Thrust to the Concrete Beams

four sides instead of two as in the one-way system. The two-way system is most efficient for bays where one side is not more than 50 per cent longer than the other. Where the percentage is greater the one-way system is better. By carrying the load to four sides it is possible to reduce the thickness of the slab and the depth of the supporting girders, but obviously it is impossible to build a two-way floor in which the percentage of tile substituted for concrete will be as high as in the one-way system.

CHAPTER XIII

Tile Used for Fire Protection

Construction of Columns

One of the constant efforts of engineers and architects in the design of buildings is to cut down the amount of steel required, without sacrificing strength in so doing. To this end long-span arches are used; short-span arches of special design to cut down the weight of the floor construction, and concrete columns, both plain and reinforced.

In previous chapters mention has been made of the value of hollow tile for structural purposes, and the strength of ordinary building blocks of this material for load carrying purposes when used under compression. In this chapter some idea will be given of special hollow tile blocks for column construction.

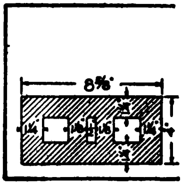


FIG. 111.—Section of Hollow Tile Used in Column Construction

A hollow tile for column construction is shown in section in Fig. 111. It will be observed that the walls and webs are about twice as thick as those of ordinary hollow tile, and for blocks of equal size the cells are consequently smaller. These blocks are made in one size, $8\frac{1}{8} \times 4 \times 8$ inches, and are therefore approximately the size of four bricks when laid in a wall.

Columns of any desired size can be made with these blocks, but the smallest built in practice is $8\frac{1}{2}$ inches

square, and the largest 31 inches square. The way the tile blocks are laid in columns of different sizes, both square and rectangular, is shown in Fig. 112. It will be observed that a half tile is needed in some of the square columns, and this is obtained by halving one of the blocks.

The safe bearing loads for these columns can be found in the following table. The values in the table are based on a ratio of one to twelve. That is, the

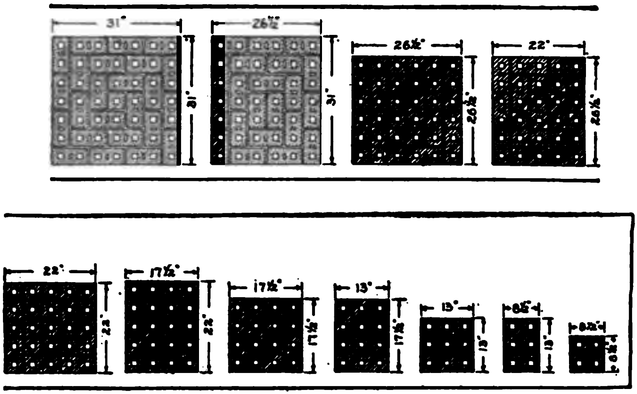


FIG. 112.—This Shows Columns of Various Sizes Laid Up with Tile Illustrated in FIG. 111

column must not exceed in height twelve times the side dimension; when the column is not square the side dimension must be the smaller dimension of the two equal sides.

An interesting comparison can be made between the strength of hollow tile columns and the strength of columns of reinforced concrete. Many building codes of large cities allow a load of only 350 pounds per

square inch on columns of reinforced concrete. A glance at the table will show that the safe load for hollow tile per square inch is as high as 692 pounds, or approximately twice the load that is allowed in practice for concrete columns.

TABLE IX

SIZES, WEIGHTS, SAFE LOADS AND NUMBER OF TILE IN COLUMNS

Size of Column, Inches	Safe Load in Pounds	No. of Tile in Cross Section	No. of Tile per Lin. Ft.	Weight of Col. per Lin. Ft., Pounds
31 x31	612,500	24½	36¾	612
31 x26½	525,000	21	31½	525
26½x26½	450,000	18	27	450
26½x22	375,000	15	22½	375
22 x22	312,500	12½	18¾	312½
22 x17½	250,000	10	15	250
17½x17½	200,000	8	12	200
17½x13	150,000	6	9	150
13 x13	112,500	4½	6¾	112½
13 x 8½	75,000	3	4½	75
8½x 8½	50,000	2	3	50

Two distinctions must be noted here, however. In the first place, 350 pounds per square inch for reinforced concrete, while it represents the limit set by some building codes, does not by any means represent what good reinforced concrete columns will support. To be perfectly safe framers of codes must provide large factors of safety, and in reinforced concrete more so than in any other form of construction in order to take care of the errors of judgment, or in some cases downright ignorance of the builders as to the proper amount and placing of reinforcement in concrete. And this element of uncertainty, which will always exist where the

human frailty or human fallibility comes into play, must be guarded against.

Reinforced concrete columns properly designed and carefully built, will safely support twice the load allowed by codes in building practice; but because of the opportunity to err, for instance, in the mixing of a batch of concrete, a very large factor of safety is exacted.

In the second place, building codes of large cities do not allow as a rule the heavy loads on hollow tile columns which they will bear. Leaning again towards the side of safety, they would probably cut down the allowable load until it would be somewhere in the neighborhood of that allowed for columns of reinforced concrete.

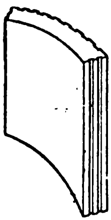


FIG. 113.—Solid Block Type for Fireproofing of Columns.

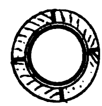


FIG. 114.—Manner of Application to an Iron Column of the Tile Illustration in FIG. 113

But even if they will carry no more than columns of equal size built of reinforced concrete, they require no steel, and the less cost, together with the absence of steel, make columns of hollow tile particularly desirable.

Hollow Tile Column Covering

Experience has demonstrated that it is absolutely necessary to protect thoroughly cast-iron or steel columns supporting walls or floors, if the building is to be saved from destruction when exposed to the flames of a fire. As was pointed out in a previous chapter, heat is the agency which destroys, not by consuming, but by heating to the bending temperature. Failure

of unprotected columns in great conflagrations has taught that important lesson.

There is an economic side to the question, too, outside of the protection to property afforded by hollow tile column covering. A low rate of insurance can be secured only when the columns are properly protected, for the durability of the building is dependent upon the stability of the columns.

There are three typical designs of hollow tile covering made for columns. The solid block type is shown in Fig. 113, and its application to a round cast-iron column

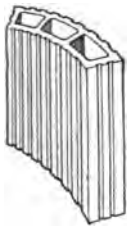


FIG. 115.—Large Cell Hollow Tile for Fireproofing

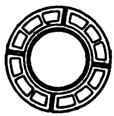


FIG. 116.—Application of Tile Illustrated in FIG. 115 to a Round Column

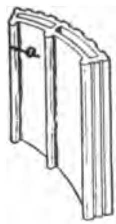


FIG. 117.—Double Cell Tile for Column Covering

is shown in section in Fig. 114. These blocks are made up in four segments of a circle, and laid up with a space between the inner side of the tile and the column, which is filled with concrete or cement mortar.

A large-cell hollow tile for column covering is shown in Fig. 115, and the way it is applied to a round iron column is shown in Fig. 116. Each succeeding course of blocks breaks joints with the course below and above.

A double-cell hollow tile for column covering is shown in Fig. 117. It will be observed that this block has ribs, *a* on the inner side. These ribs serve a double

purpose. In the first place they keep the hollow tile blocks a certain and equal distance from the column; and in the second place the ribs thus form either air cells or spaces for concrete, whichever is called for. If the columns are of cast-iron the spaces may be left unfilled, and the ribs then form air cells. If the columns are of steel, on the other hand, the space between the hollow tile and the steel should be filled with cement mortar or concrete to prevent the possibility of corrosion and for additional security against fire.

Square columns are generally encased in square

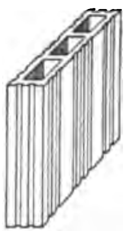


FIG. 118.—Tile for a Square Column

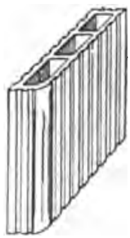


FIG. 119.—Tile Used When Round Corners Are Desired

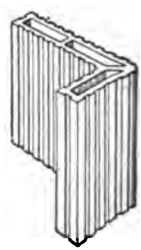


FIG. 120.—Another Type of Tile with Round Corners

coverings made of partition tile, set to break joints. A block of this description is shown in Fig. 118. When rounded corners are desired they may be had by using blocks similar to that shown in Figs. 119 or 120.

Typical cross sections of both circular and square columns showing the various methods of treatment, not only to protect against fire and corrosion, but also overload, are not without interest to the practical builder. In Fig. 121 is shown an H column protected by hollow tile with rounded corners. It will be observed that the space between the inner side of the tile

and the steel column is filled with concrete. This is to protect the column from corrosion and afford additional protection from fire. But a half inch of cement mortar or concrete will protect from corrosion as well as a foot will, while air cells in the concrete would afford even better protection against fire. Where the columns are large enough to permit it, therefore, hollow tile blocks are bedded in the cement as shown in Fig. 122. Another thing to note about this illustration is that the rivets keep the hollow tile from being laid against the end plates. That is a good thing, as it affords ample space for a protecting layer of cement or concrete.

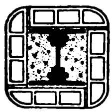


FIG. 121.—An H-column Protected By Round Cornered Hollow Tile

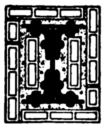


FIG. 122.—Where Columns Are Large Enough, Tile Are Bedded in the Cement

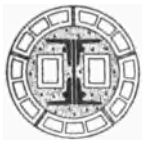


FIG. 123.—Circular Tile Used to Cover the Same Type Column Shown in FIG. 122

In Fig. 123 the same type of steel column is shown encased in circular tile coverings. This not only affords the greatest amount of protection against fire and corrosion, but is a light form of construction, and the concrete and hollow tile add greatly to the strength of the column.

The box type of column is shown in Fig. 124 covered with square column covering similar to Fig. 119, while a like column is shown in Fig. 125 covered with square column covering similar to Fig. 120. In both these illustrations the spaces between the inner surface of the tile and the steel columns is completely filled with concrete.

Fig. 126 shows in perspective a solid type of round column covering which is very thick and fluted or ribbed on the inside so that air spaces are formed. The ribs likewise help to keep the blocks equal distances from the columns when set in place. Fig. 127 shows

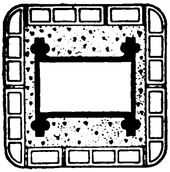


FIG. 124.—Box Type of Column Fireproofed with Hollow Tile

FIG. 125.—Column Fireproofed with Tile Similar to That Shown in FIG. 120

a cross section of a round column where this type of column covering is used.

One method of enclosing a cross column is shown in Fig. 128. Instead of treating it in that manner, however, round column covering could be used, or square

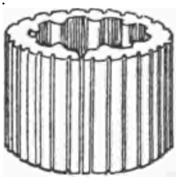


*FIG. 126.—Solid Type of Tile for Round Column

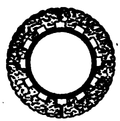


FIG. 127.—Cross Section of Column in which Is Used the Tile Illustrated in FIG. 126.

column covering, and the spaces in the angles could be filled with concrete and hollow tile.

We come now to a phase of the subject of column covering which is more architectural in its treatment or

*Some types of column covering shown are not manufactured now, but are illustrated, as they are still in use.

purpose than engineering or fire protection. That is, the covering of pipes where they pass up through a building alongside of columns. It is not necessary to cover pipes to keep them from being destroyed by heat of fire, for if they should be it would not endanger the stability of the structure. Pipes are unsightly, however, when exposed alongside of columns in a room or corridor, so provision has been made by the fireproofer to hide them from sight.

In Fig. 129 is shown one method of carrying pipes

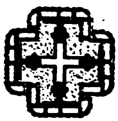


FIG. 128.—Fireproofing a Cross Column

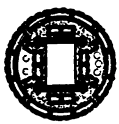


FIG. 129.—Pipes Carried Up Inside of Coverings

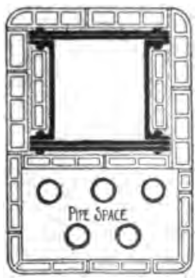


FIG. 130.—Here the Pipes Are Carried Up in a Separate Space Alongside the Column

up inside of round column coverings, and Fig. 130 shows how they may be carried up inside of square column coverings. It will be observed in both illustrations that the hollow tile blocks can be removed from in front of the pipes, thereby exposing them for inspection and repairs, without endangering the columns by exposing them to the danger of fire. In other words, a complete unbroken layer of hollow tile blocks is carried around the column, and additional space enclosed with tile blocks in which the pipes can be run.

CHAPTER XIV

Protection of Beams and Girders

The specifications for fireproofing buildings generally state: "All girders, beams, channels, and all other steel members which show below the under side of the ceilings are to be encased on all sides with at least one-half inch thickness of fireproof tile secured to

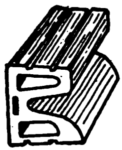


FIG. 132.—A Heavy Semi-porous Clip Tile for Covering Flanges

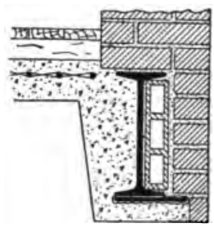


FIG. 131.—Protecting Girder Which Spans a Wall Opening

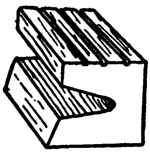


FIG. 133.—Solid Type of Clip Block, Used for Same Purpose as FIG. 132.

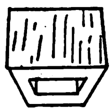


FIG. 134.—Hollow Soffit Tile

the steel in the usual manner. If required, special designs must be submitted to the architects."

It was about this very matter—the protecting of beams and girders from fire—that a well-known structural engineer of national reputation recently said: "Should a steel floor beam soften in a fire and fail, the

falling tile would no doubt bring down every arch at a lower level in that bay. Should a girder fail, that is, one of the main girders which support a number of iron beams, the resulting crash of falling material would no doubt wreck the entire interior of the building, if indeed it did not carry with it some of the walls as well."

That is why such care is taken to protect steel beams and girders in skeleton construction by encasing them in hollow tile. As the size of the beams and girders vary, and there are a number of ways in which they may be used in combination, there must be a number of designs of hollow tile to take care of all conditions.

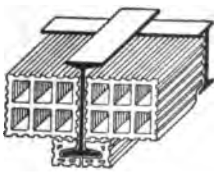


FIG. 135.—Hollow Soffit Tile with Ribs on Upper Surface

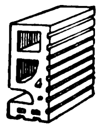


FIG. 136.—Combination Clip and Partition Tile Used Where Beams Are Extra Deep

The protection of a girder spanning an opening in a wall is shown in Fig. 131. It will be observed that the beam is bedded on all sides with concrete or cement mortar, which protects it from corrosion; and that on all sides are several inches of brick, hollow tile or concrete to protect it from the heat of a fire.

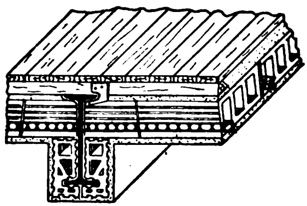


FIG. 137.—Tile Shown in Fig. 136 Used to Fireproof an I-beam

Girder coverings require special blocks to cover the lower flanges or exposed surfaces, and those special blocks are known as "clip" tile and "soffit" tile. A heavy semi-porous clip tile is shown in Fig. 132. It

will be observed that there are cells running through this block. In Fig. 133 is shown a solid porous clip block which has no air cells running through it. In Fig. 134 is shown a hollow soffit tile, and in Fig. 135 a hollow soffit tile with ribs on the upper surface which hold the tile from the under side of the beam flange, thereby providing another air space or cell.

It will be noticed that the soffit tile and clip tile are either porous or semi-porous material. Experience has proven that porous tile is the very best material to use for this purpose, and that next to porous comes semi-porous tile. They are both poor conductors of heat, and are not destroyed by the action of fire, nor by being drenched with water while in a heated condition.

The lower flanges of single beams are usually covered with clip tile. When the beams are extra deep, the webs are protected either by partition tile or extra deep beam tile, which are combination clip and partition tile, as shown in Fig. 136. In Fig. 137 can be seen the way these tile make up on a beam.

Where double beams are used, the soffits are covered by a soffit tile, as shown in Fig. 138, fitting into the bevel of the clip tile. For plate girders and where the space to be spanned is very wide, the soffit should be hung on metal clips, as shown in Fig. 139. The metal clips must be protected from heat or flame, or they will fail in a fire.

The girder coverings may be set at the time the arches are laid, or they may be put in later. If set with the arches, the partition tile, *a*, Fig. 140, which rests on the clip tile, is held in place by the arch. If set later, the space between the clip tile and the bottom

of the arch is filled with a low tile, *b*, or hollow brick. This is important for the builder to note, for it will sometimes be advisable to set the arches and cover the soffits of the beams later.

Channel beams should never be used for supporting hollow tile arches except when they are backed up against a brick or hollow tile wall, for it is almost im-

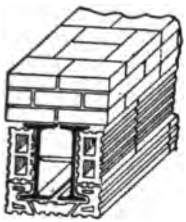


FIG. 138.—With Double I-Beams, Soffit Tile Are Used As Here Shown

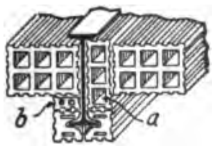


FIG. 140.—Partition Tile Can Be Used As at A, or a Hollow Brick or Low Tile Can Be Used as at B

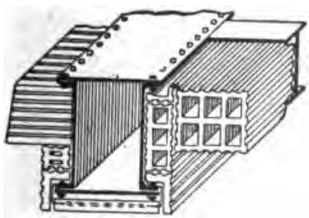


FIG. 139.—Where the Lower End of the Beam Is Very Wide, the Soffit Tile Are Hung on Metal Clips

possible to properly protect them against fire and corrosion, except at a greater expense than I-beams would cost.

It might seem unnecessary, still at the same time it will be well, to call the reader's attention to the fact that in all the illustrations showing beam and girder

covering, the cross beams between which the arches are sprung are at right angles to the beams and girders. That is indicated by the cross section of the blocks. It will be remembered that end construction is the type commonly used at the present time, so that the sections shown indicate a line cut through a row of lengtheners. It follows as a natural course, therefore, that there is no thrust against the sides of the beams or girders; and that explains why a row of partition blocks of hollow tile can be used alongside of a plate girder, as shown in Fig. 139, to protect the web. There is no crushing thrust against it whatsoever It serves simply and solely as a filler and protection for the girder against fire. As was explained in a former installment, whenever an arch is sprung between two beams, skewbacks are used. If simply set in between two partition tiles, as shown in Fig. 139, the arch would fall of its own weight.

When hollow tile arches are built, the keys are set in place, thus strongly wedging the span; and when all the arches are in position in the several floors, they make the building perfectly rigid. Any form of composition flooring which would shrink more or less upon drying or seasoning would not only load the frame with an inert mass, but would add nothing to its stiffness.

Weights of Arches

The net weights of hollow tile arches of various thicknesses can be found in the following table:

Weight of ordinary 4-inch solid brick segmental arch, 38 pounds per square foot.

Weight of ordinary 8-inch solid brick segmental arch, 80 pounds per square foot.

Weight of ordinary 4-inch H. T. segmental arch, 31 pounds per square foot.

Weight of ordinary 8-inch H. T. segmental arch, 65 pounds per square foot.

Weight of ordinary 6-inch hollow tile segmental arch, 27 pounds per square foot.

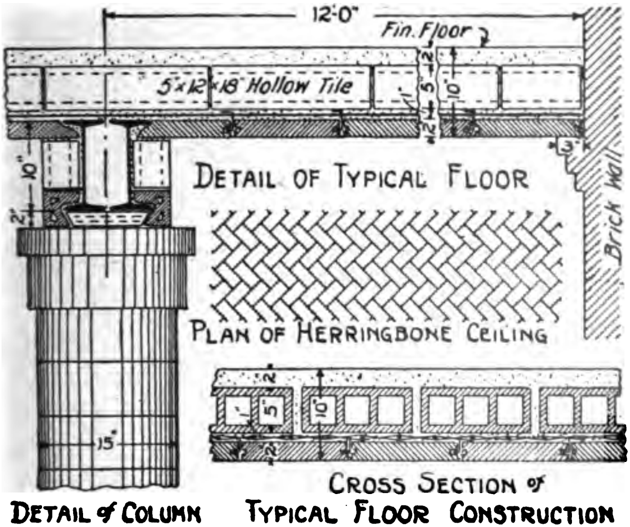


Fig. 141.—Type of Construction Used with Long Span Segmental Arches

Weight of ordinary 8-inch hollow tile segmental arch, 35 pounds per square foot.

It might be interesting to the practical builder to give an illustration and description of a system of fireproofing which is about the highest type of a thoroughly fireproof building that has ever been designed. Severa details grouped together are shown in Fig. 141. Thes

FIG. 154.—Modified Spanish Design. Common to the Extreme Southwest

Weight of ordinary 4-inch H. T. segmental arch, 31 pounds per square foot.

Weight of ordinary 8-inch H. T. segmental arch, 65 pounds per square foot.

Weight of ordinary 6-inch hollow tile segmental arch, 27 pounds per square foot.

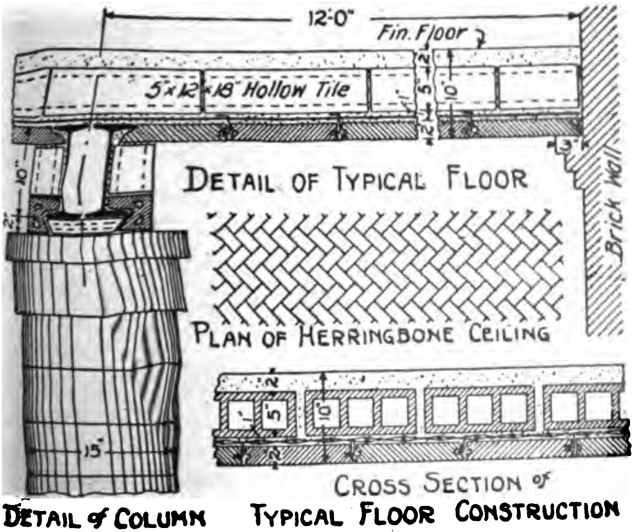


FIG. 141.—Type of Construction Used with Long Span Segmental Arches

Weight of ordinary 8-inch hollow tile segmental arch, 35 pounds per square foot.

It might be interesting to the practical builder to gi an illustration and description of a system of firepr ing which is about the highest type of a thoroug proof building that has ever been designed. Sev grouped together are shown in Fig. 141. Th

FIG. 156.—Colonial Design Up-to-the-minute

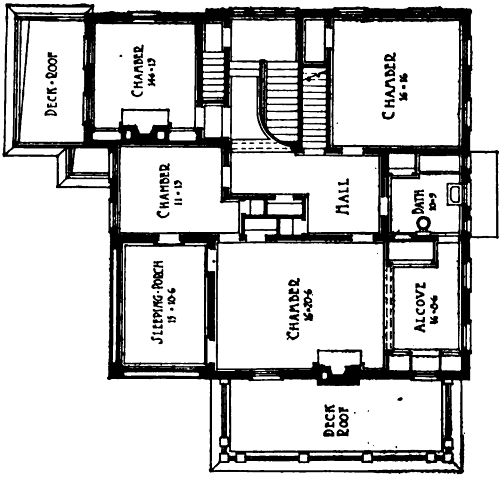


FIG. 157.—Second Floor of Colonial Building

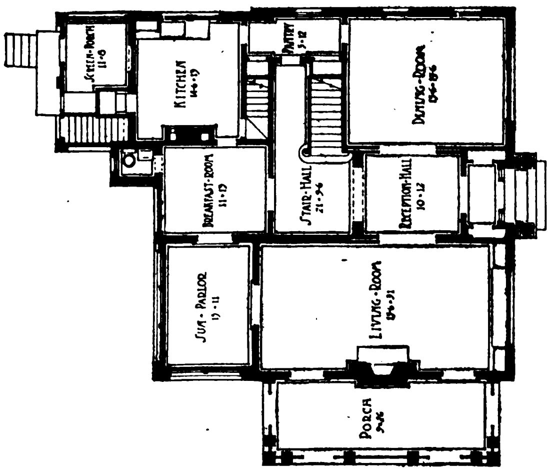


FIG. 158.—First Floor Plan of Colonial Building

FIG. 159.—As Seattle Architects Use Hollow Tile

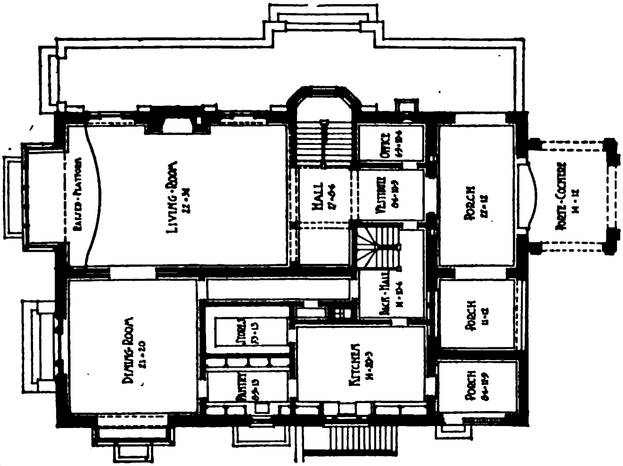


FIG. 160.—First Floor of Seattle Building

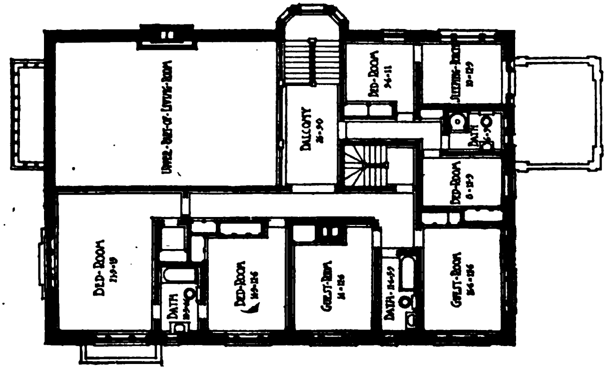


FIG. 161.—Second Floor of Seattle Building

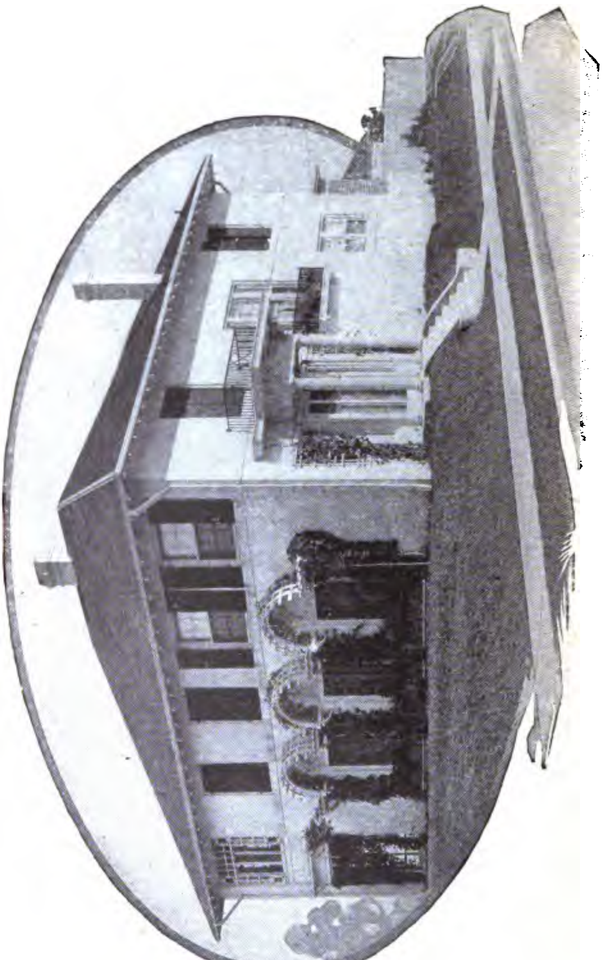


FIG. 162.—A Good Example of Stuccoed Hollow Tile

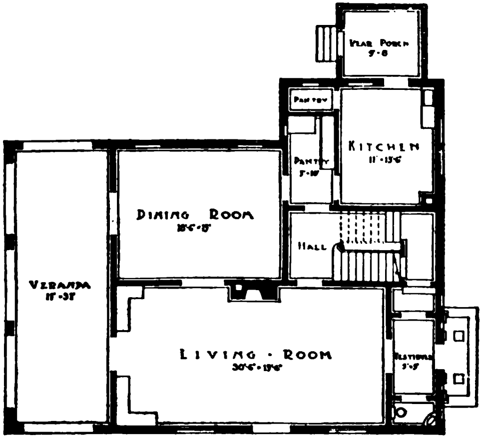


Fig. 163.—First Floor Plan of Stuccoed Building

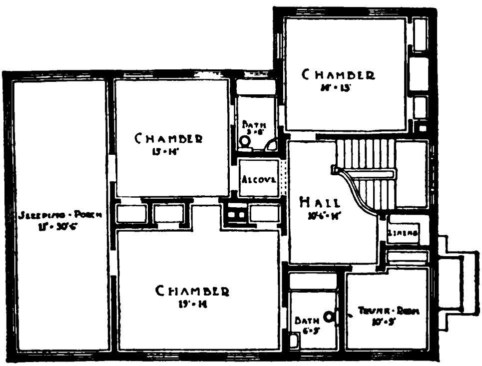


Fig. 164.—Second Floor Plan of Stuccoed Building

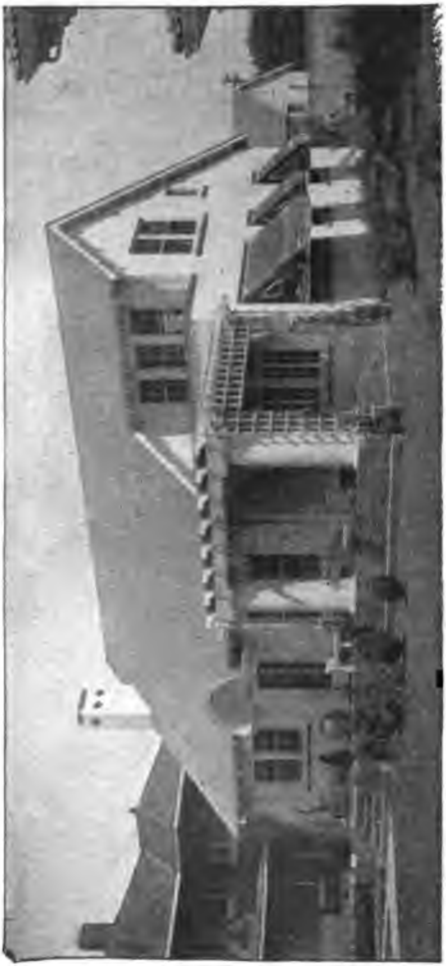


Fig. 165.—A Comfortable Cottage of Hollow Tile

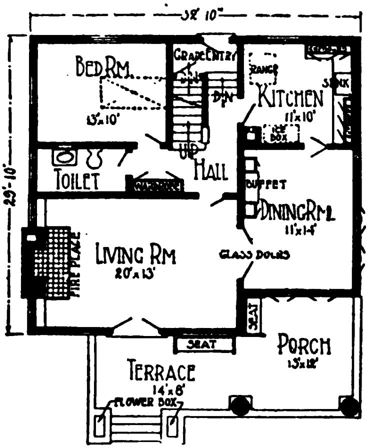


Fig. 166.—First Floor Plan of Cottage

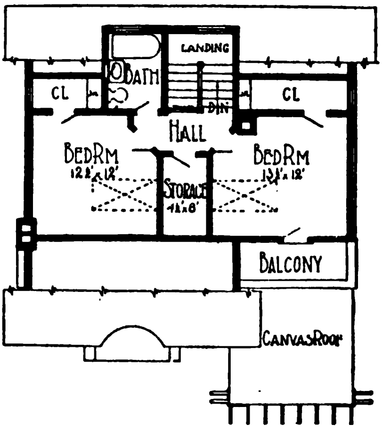


Fig. 167.—Second Floor Plan of Cottage

FIG. 168.—Country Residence in Massachusetts

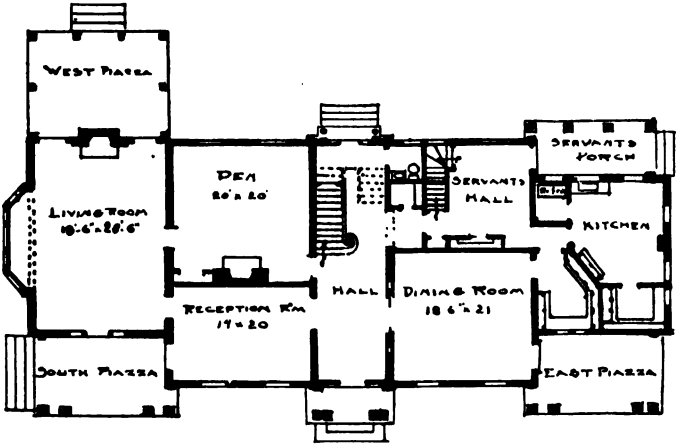


Fig. 169.—First Floor Plan of Country Residence

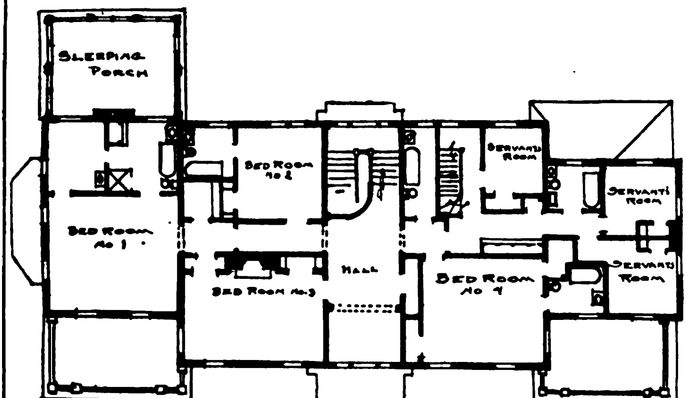


Fig. 170.—Second Floor Plan of Country Residence

FIG. 171.—A Double Bungalow of Hollow Tile

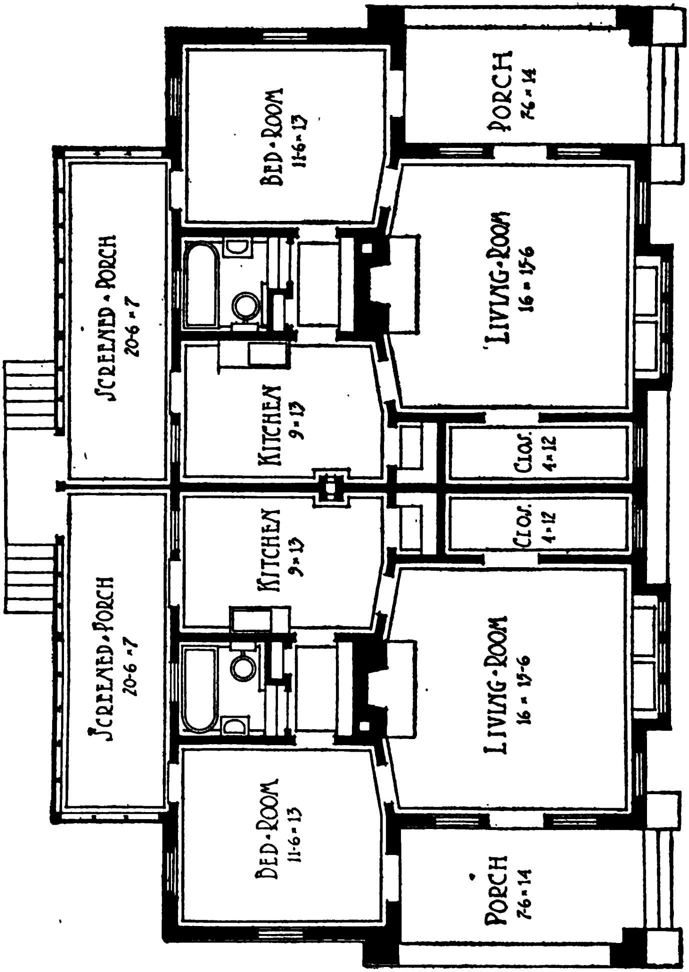


FIG. 172.—Interesting Floor Plan of 3-room Double Bungalow

FIG. 173.—A New England Type of Brick and Hollow Tile Building

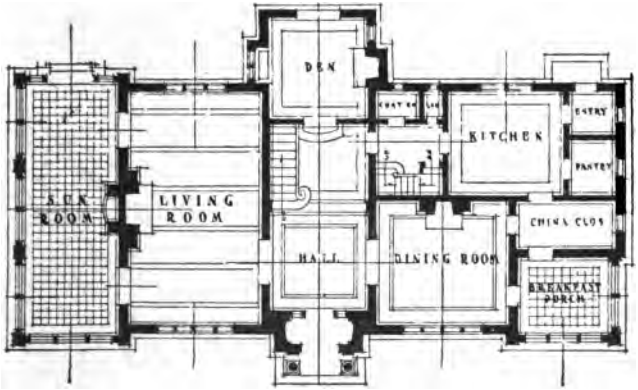


Fig. 174.—First Floor Plan of Brick and Hollow Tile Building

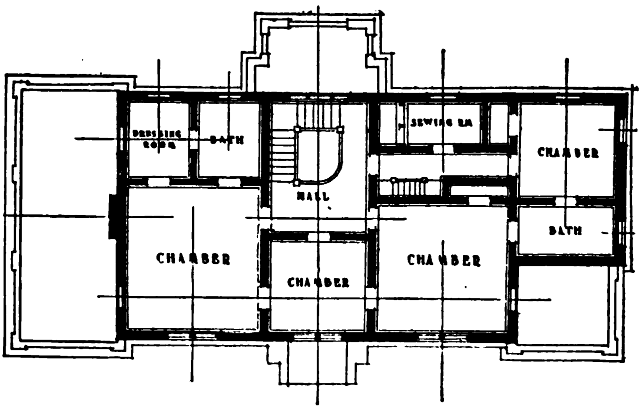


Fig. 175.—Second Floor Plan of Brick and Hollow Tile Building

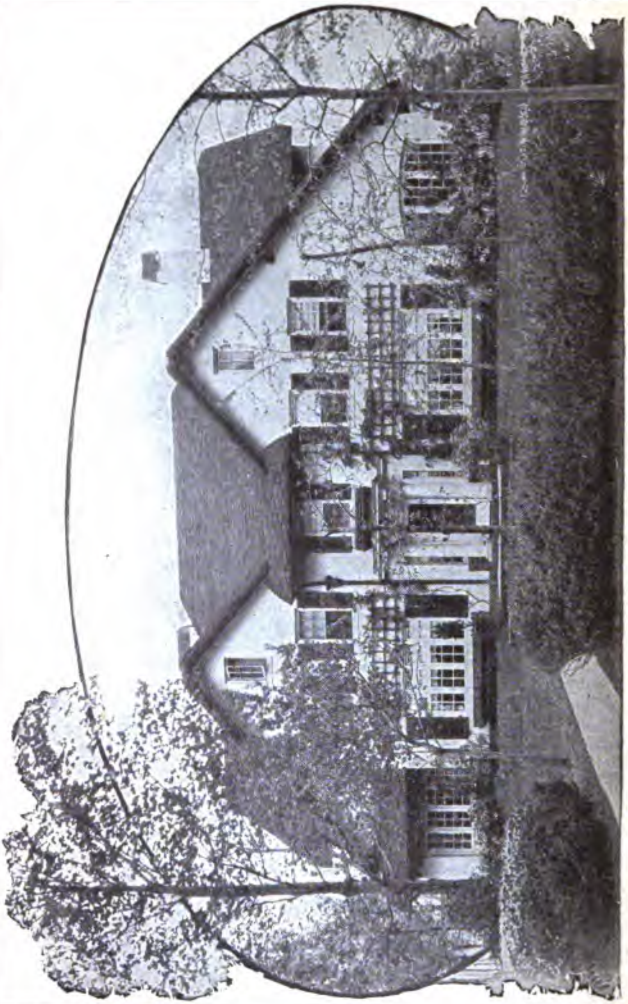


FIG. 176.—A Suburban Home Near Cleveland, Ohio

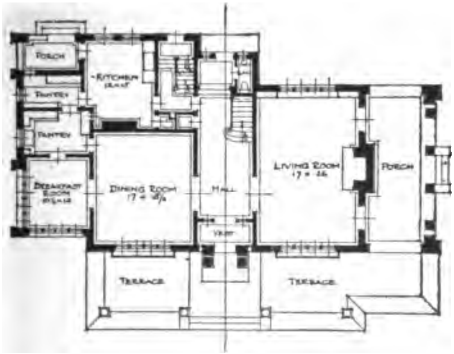


FIG. 177.—First Floor Plan of Suburban Building

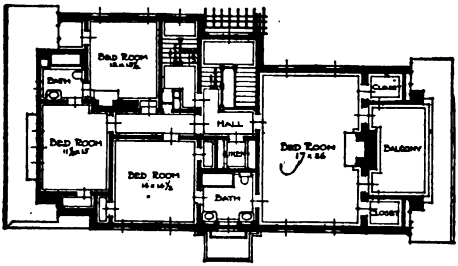


FIG. 178.—Second Floor Plan of Suburban Building

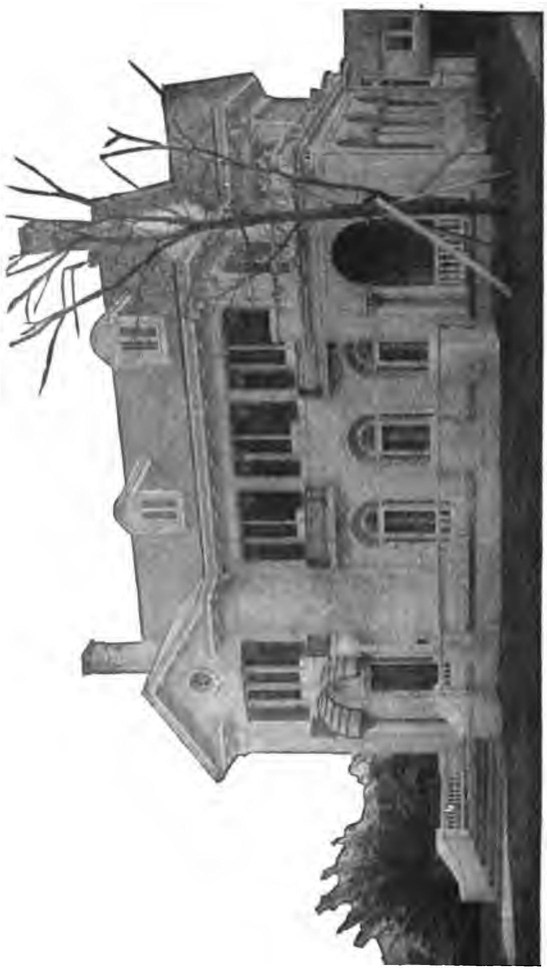


FIG. 179.—Formal Type of City Building, Texas

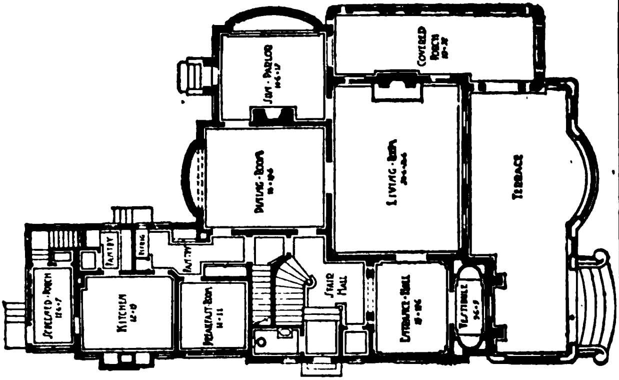


FIG. 180.—First Floor Plan

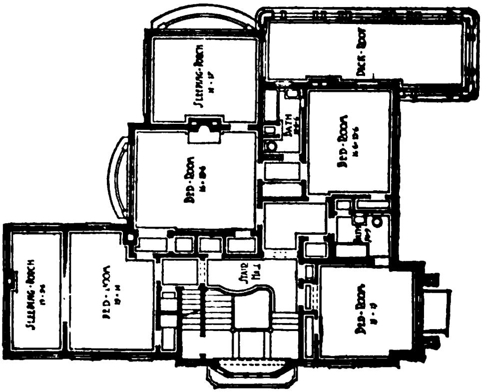


FIG. 181.—Second Floor Plan

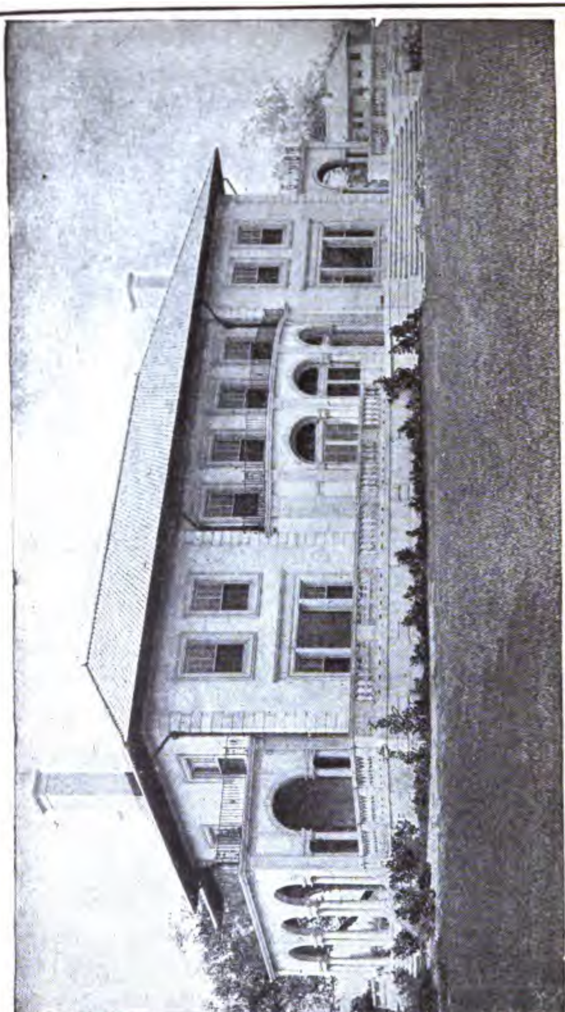


FIG. 182.—California Type of Stuccoed Hollow Tile

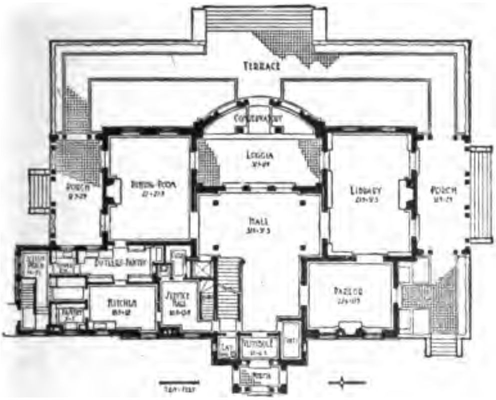


Fig. 183.—First Floor Plan of California Building

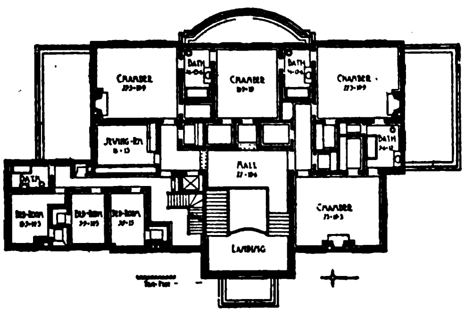


Fig. 184.—Second Floor Plan of California Building

Fig. 185.—Italian Design Chicagoized. A Good Example of Stucco on Hollow Tile

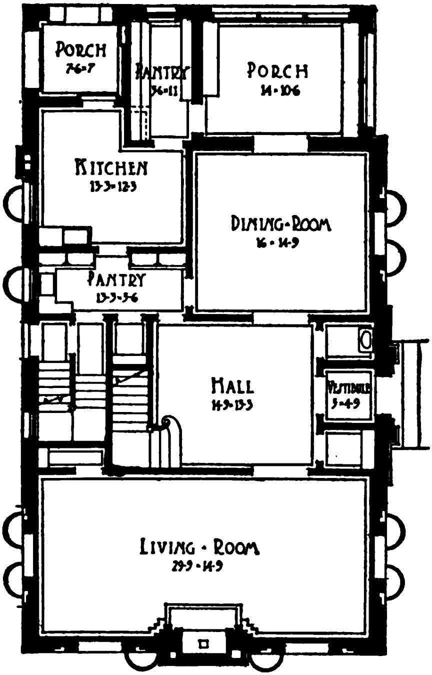


FIG. 186.—First Floor Plan

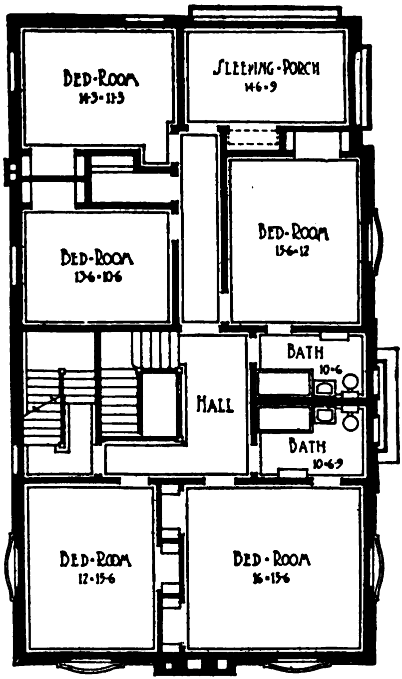


FIG. 187.—Second Floor Plan

INDEX

A

PAGE

Analysis of Specifications 145
Arches, How to Build Flat 84
Arches, Long-span 151
Arches, Reinforced Flat 95
Arches, Short and Long Span Segmental 99
Arches, Strength of Flat 91
Arches, Tie-rods for 105
Arches, Weight of 134

B

Beam Filling and Floor Finish 138
Beam Filling and Floors 150
Beams and Girders, Protection of 130
Beams, Reinforcing Concrete 113
Bearing Walls, Tile Blocks for 34
Blocks for Bearing Walls, Tile 34
Blocks for Wall Openings, Special 9
Blocks, Nailing 149
Blocks, Types of Building 1
Book Tile 71
Breakage, Calculating the 155
Brick and Tile Walls, Difference in Labor Between 160
Building Blocks, Types of 1
Buildings, Roofing Hollow Tile 62
Bulkheads and Toilet Room Floors 150
Bulkheads, Roofs and Floors 71
Buttresses 58
Buttresses, Gables and Pipe-chases 53

C

Calculating the Breakage 155
Chimneys, Fireplaces and Oriel Windows 44
Column Covering, Hollow Tile. 149
Column Covering 149
Columns, Construction of 121
Combination Floors, Construction of 109
Concrete Beams, Reinforcing 113
Concrete, Forms for 113
Construction of Columns 121
Construction of Combination Floors 109

PAGE

Cost, Getting the Tile at the Lowest 157
Cost of Laying Tile 153
Covering, Column 148
Covering Exposed Steel Work 149
Covering, Hollow-tile Column 149

D

Details 146
Difference in Labor Between Brick and Tile Walls 160
Drips, Window Sill 13

E

Equipment, What Should Be Charged for 162
Estimating the Labor Required 158
Exposed Steel Work, Covering 149

F

Finish, Wall 17
Fireplaces, Chimneys and Oriel Windows of Hollow Tile 44
Fire Proofing with Hollow Tile 81
Fire Protection, Tile Used for 121
Flat Arches, How to Build 84
Flat Arches, Reinforced 95
Flat Arches, Strength of 91
Floor-finish and Beam-filling 138
Floors and Beam Filling 150
Floors, Bulkheads and Toilet Room 150
Floors, Construction of Combination 109
Floors, Roofs and Bulkheads of Hollow Tile 71
Flue Linings 45
Forms for Concrete 113
Furring Tile 148

G

Gables 60
Gables, Buttresses and Pipe-chases 53
General Provisions 146
Getting the Tile at the Lowest Cost 157
Girders and Beams, Protection of 130
Grades of Hollow Tile 7

H

Height of Tile Partitions 26
Hollow Tile Buildings, Roofing. 62
Hollow Tile Column Covering 149

PAGE

Hollow Tile, Cost of Laying 153
Hollow Tile, Fireproofing with 81
Hollow Tile Partitions 24
Hollow Tile, Grades of 7
Hollow Tile, Uses for 2

L

Laying Method 154
Labor, Difference in Between Brick and Tile Walls 160
Labor, Estimating 158
Laying Hollow Tile, Cost of 153
Linings, Flue 45
Long-span Arches, Specification for 151
Long-span Segmental Arches 99
Lowest Cost, Getting Tile at 157

M

Method of Laying 154

N

Nailing Blocks 149
Number of Tile That Can Be Laid in a Day 153

O

Oriel Windows, Fireplaces and Chimneys 44
Overhead 162

P

Partitions 148
Partitions, Height of Tile 26
Partitions, Hollow Tile 24
Partitions, Porous Tile in 28
Pipe Chases, Buttresses and Gables 53
Porous Tile in Partitions 28
Protection of Beams and Girders 130
Protection, Tile Used for Fire 121

R

Reinforcing Concrete Beams 113
Reinforced Flat Arches 95
Roofing Hollow Tile Buildings 62
Roofs, Floors and Bulkheads 71

PAGE

S

Segmental Arches, Short and Long-span 99
Short and Long Span Segmental Arches 99
Shrinkage of Timbers 11
Specifications, General 146
Special Blocks for Wall Openings 9
Specifications, Analysis of 145
Steel Work, Covering Exposed 149
Strength of Flat Arches 91
Strength of Tile Walls 5

T

Tie Rods for Arches 105
Tile 147
Tile and Brick Walls, Difference in Labor Between 160
Tile at Lowest Cost, Getting 157
Tile Blocks for Bearing Walls 34
Tile, Book 71
Tile, Furring 148
Tile Used for Fire Protection 121
Tile Walls, Strength of 5
Timbers, Shrinkage of 11
Toilet Room Floors and Bulkheads 150
Two Uses for Hollow Tile, The 2
Types of Building Blocks 1

W

Wall Finish for Hollow Tile 17
Wall Openings, Special Blocks for 9
Walls, Difference in Labor between Brick and Tile 160
Walls, Strength of Tile 5
Walls, Tile Blocks for Bearing 34
Water Tables 19
Weights of Arches 134
What Equipment Should Be Charged For 162
Window Sill Drips 13

W. B. C.